TO INTERVENE OR NOT TO INTERVENE:

EFFECTS OF BEHAVIOURAL SLEEP INTERVENTIONS

ON INFANT ATTACHMENT QUALITY

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Abstract

This study aimed to explore the relationship between infant sleep disturbance (ISD) and attachment quality in 1-year-old infants, within two groups of families differing in their help-seeking preferences; and to investigate the effects of behavioural sleep interventions (BSI) on infant attachment and family wellbeing. A mixed design of pre-/ post-test prospective longitudinal and single-case design with a multiple baseline across participants was employed, with four data collection phases over 4 to 6 months. Twenty four participants (age range = 11-16 mo., *M* = 13.16 mo., *SD* =1.32; 58% boys) completed the first phase and 18 participants completed all four phases of the study (*n* = 10 completed a BSI, *n* = 8 provided comparison data). Attachment was measured via the Strange Situation Procedure at baseline and follow-up. Sleep patterns were measured continuously while the severity of sleep problems, infant perceived and observed negative emotionality, parental cognitions about infant sleep, nighttime and daytime behaviours, and parental wellbeing were measured once at each phase. The standard multiple regression analyses with *n* =24 revealed that ISD and attachment variables were not associated at baseline. ISD was associated with parental nighttime involvement, feeding beliefs, nighttime limit setting difficulties and less infant negative emotionality. Intervention (*n* = 13) and comparison (*n* = 11) groups at baseline were different in their cosleeping practices and the onset age of ISD. A Discriminant Function Analysis indicated that parents who wanted to receive a BSI were more likely to set limits at night-time and their infants cried less during a short separation. Visual analysis of time-series data from all phases indicated that after receiving a BSI 80% of the intervention infants no longer had ISD and comparison infants continued having ISD with only small improvements. Analysis of point-per-phase data using the modified Brinley Plots showed that BSIs did not cause any harm to the infant, parent, and their attachment relationship and improved the overall family wellbeing. A gradual improvement in infants' sleep in the comparison group was predicted by having consistent secure attachment. Overall, ISD was not found to be related to infant attachment quality and treatment outcomes indicated positive results in favour of intervening with ISD.

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Glossary

ABC	Avoidant-insecure, secure, and ambivalent/resistant-insecure attachment patterns
ABCD	Avoidant-insecure, secure, ambivalent/resistant-insecure, and disorganised-insecure attachment patterns
AQS	Attachment Q-Set
CBCL 2/3	Achenbach Child Behavior Checklist for Ages 2-3
CSS	Composite sleep score
DASS-21	Depression, Anxiety, and Stress Scale 21-item Form
DFA	Discriminant Function Analysis
DV	Dependent variable
ICC	Intra-class correlation coefficient
ICQ	Infant Characteristics Questionnaire
ISD	Infant Sleep Disturbance
MBP	Modified Brinley Plots
MCISQ	Maternal Cognitions about Infant Sleep Questionnaire
Mini-MBQS-V-Revised	The Revised 25-item Maternal Behavior Q-Set for Video
NE	Negative Emotionality
NICHD	National institute of Child Health and Human Development
NWDUR	Duration of night waking
NW	Night waking
RCI	Reliable change index
SSP	Strange Situation Procedure
VSG	Videosomnography

Introduction

Remarkable changes happen within the first year of an infant's life. Among these changes, attachment and sleep development seem to be two very important processes. Sleep is a complex bio-behavioural state which is an essential part of infancy and functions as a facilitator for an infant's brain development (Blampied & Bootzin, 2013). Attachment, on the other hand, is a construct associated with the organisation of dyadic interactions between infant and caregiver which is associated with various aspects of a lifelong healthy development (Sroufe, Egeland, Carlson, & Collins, 2005). Although there is a biological component to them both, as a necessity to survive, both sleep patterns and attachment patterns develop through experience (Blampied & Bootzin, 2013; Bowlby, 1969).

Pathways of these two processes are believed by some authors to cross at the emergence of Infant Sleep Disturbance (ISD) and attachment insecurity (Keller, 2011) and recent studies indicate a possible relationship between healthy sleep patterns and attachment security (Simard, Chevalier, & Bédard, 2017). The relationship between ISD and attachment insecurity needs further assessment as they both develop around the first two years of life, both have an effect on later functioning, and both of them are independently associated with similar contextual factors. However, they also have the potential to change either naturally or with the help of intervention. In fact, there are studies indicating that attachment-related interventions for parents tend to reduce parent-reported infant sleep problems (Cramer et al., 1990; Spieker, Oxford, Kelly, Nelson, & Fleming, 2012) and behavioural sleep interventions (BSI) are repeatedly demonstrated to improve not only the infant's sleep, but also wellbeing of the infant and family (Črnčec, Matthey, & Nemeth, 2010; Eckerberg, 2004; France, 1992; Mindell, Kuhn, Lewin, Meltzer, & Sadeh, 2006).

Despite the growing evidence on the effectiveness of behavioural sleep interventions to improve infants' sleep and family wellbeing (Hall, Moynihan, Bhagat, & Wooldridge, 2017; Mihelic, Morawska, & Filus, 2017), some authors claim without empirical evidence that implementing BSI may disrupt or even harm the quality of parent-infant attachment, and hence, lead to attachment insecurity or even disorders of attachment (Blunden, Thompson, & Dawson, 2011; Hiscock & Fisher, 2015). Although there has been a considerable interest in bidirectional influences of infant sleep and attachment in recent years (Adams, Stoops, & Skomro, 2014), there were only three studies to explore the impact of sleep interventions on the infant attachment or related constructs (France, 1992; Gradisar et al., 2016; Price, Wake, Ukoumunne, & Hiscock, 2012). However, to our knowledge, there has not been a study to explore the impact of behavioural sleep interventions on the attachment organisation of infants by assessing the quality of attachment relationship before and after the intervention while also following the possible natural change in both attachment and sleep.

Thus, the focus of this research project is to ascertain whether or not implementing a well-established, gradual behavioural sleep intervention for 1-year-old infants with sleep disturbance has an effect on the development of parent-infant relationships, with a specific emphasis on the quality of attachment patterns and/or attachment behaviours of infants. It is aimed to provide preliminary data for further discussions on the relationship between sleep and attachment and to contribute to the ongoing debates around the effects of BSIs on parent-infant relationship by in-depth examination of change, as a function of a BSI or through time, in sleep, attachment, and contributing factors affecting both infant attachment quality and ISD.

In this section, firstly, the commonalities between attachment and sleep literature is described broadly. Secondly, in the light of theoretical suggestions on the possible mechanisms between sleep and attachment, the current literature is systematically reviewed. Thirdly, studies on BSIs and their effects on the quality of attachment in infants and older children are summarised. Lastly, the rationale of the study and research questions are introduced.

Background Information

There are many commonalities between infant sleep and attachment and these can be listed as: their timing; both being necessary for survival; both having biological and intrinsic components but their patterns develop through experience; individual differences result from interactions in genetics and other constructs at proximal and distal levels (associations); both are associated with later functioning of children for better (for security and healthy sleep) or worse (for insecurity and unhealthy sleep); and finally, they both have the potential to change either naturally or through intervention. Both constructs have massive literature backgrounds, therefore the background information presented here has been organised to cover only the commonalities between sleep and attachment.

Behavioural Mechanisms of 'Falling Asleep'

Sleep is an important part of infancy for the development, maintenance and nurture of the central nervous system as neurological and physiological activities continue intensely during sleep (Bathory & Tomopoulos, 2017; Davis, Parker, & Montgomery, 2004a). Although sleep itself is a biological state, how humans fall asleep is determined through learned behaviour (Blampied, 2013). The behavioural approach, specifically, modern learning theory, provides a model to explain the mechanisms of sleep-to-wake and wake-to-sleep transitions. According to this model (Blampied & Bootzin, 2013; Blampied & France, 1993), falling asleep is an operant behaviour as the sleep state is the reinforcement.

The sleep process is defined by Blampied and Bootzin (2013) as a bio behavioural state because the biological state of sleep cannot be conditioned to never occur or always occur, that is, one cannot be punished or reinforced to sleep more or less. Human biological homeostasis, through sleep pressure, at some point, usually after fatigue, commences and this fundamental need is fulfilled. However, entering, maintaining, and coordination of sleep are determined with a chain of behaviours which are reinforced with repetition and predicted outcomes.

In Skinner’s (2013/1969) classical three-term contingencies of reinforcement, which are antecedent stimuli, behaviour, and response consequences, sleep state corresponds to response consequence, which is intrinsically motivating, and the behaviour corresponds to falling asleep. The antecedents of falling asleep are chains of behaviours which may begin with preparations for bedtime including a bedtime routine (Staples, Bates, & Petersen, 2015), such as putting on pyjamas, and continue with the environmental context, such as the bed and dim light, and preparation of the body by getting into the body posture or orientation that is linked with falling asleep (Bootzin, 1977). These chains of behaviours end with a behavioural quietude which becomes the consummatory response to falling asleep, meaning, it consumes the reinforcement of sleep (Blampied, 2013).

Behavioural quietude is achieved by reducing all behavioural activity so that the individual focuses on the internal cues for sleep (Blampied & France, 1993). In infancy, the term “self-soothing” (Anders, 1992) refers to this notion of decrease in perceptual stimulation and overt behaviours so the infant can initiate sleep without adult assistance (Goodlin-Jones, Burnham, Gaylor, & Anders, 2001). Infants may use sleep aids such as thumb sucking or snuggling a blanket as part of the contingencies needed for transition (Burnham, Goodlin-Jones, Gaylor, & Anders, 2002b). As sleep is highly important in infancy and intrinsically more needed by infants, the antecedents of falling asleep may be more variable and less strict than an adult would need. Nevertheless, having consistent antecedent stimuli helps infants to establish a behaviour repertoire of falling asleep which makes it easier for them to transition through developmental phases of sleep (Blampied & Bootzin, 2013).

Behavioural Mechanisms of Attachment

Attachment, or infants' tie to their mother, was theorised by Bowlby (1969) as a response to psychoanalysis-oriented object-relations theory which was the paradigm of the time (Bretherton, 1992). According to attachment theory, every human infant has the need to form a tie to a caregiver in order to survive and avoid danger (Bowlby, 1969, 1982, 1988). To form this bond, the nature of mother and infant works together in a systematic way (Sroufe & Waters, 1977).

Bowlby (1982) laid the foundations of attachment theory on his "control systems model" of development, which is suggested to be an equivalent of the later-developed term "cognitive architecture" (Petters & Waters, 2017). He was inspired from ethology, biology, evolutionary theories and research with primates. The proposed behavioural systems were universal for all species with small differences based on the environmental context. Each behavioural system consists of a set of inter-changeable, functionally equivalent behaviours that have the same predictable effect or outcome and each behaviour may serve more than one behavioural system. These behaviours, and so the behavioural systems, were selected through evolution as they fulfil a biological function. The function for behavioural systems mentioned within attachment theory is to help ensure the survival and reproductive process of the individual and their genes. Selection, activation, and termination of behavioural systems are based on individual's internal state and the environmental context.

Behavioural systems differ in their structural complexity. Reflexes, such as sucking, are the most basic behavioural systems followed by fixed action patterns such as feeding from the breast or a bottle. Bowlby called the more sophisticated and complex chain of behaviour reactions to achieve a predicted outcome as 'goal-corrected' behaviours in which there are activating and terminating conditions and they have predictable outcomes and the process to achieve the outcome is more complex.

Other than feeding and caregiving, four behavioural systems come forward in attachment theory: attachment, fear/wariness, exploration, and sociability. The biological function of attachment and fear/wariness is protection of the younger individuals from a wide range of dangers. The biological function of exploration and sociability is learning the skills necessary for more self-reliant survival both in terms of individual skills and to integrate younger individuals into the social group smoothly.

Mary Ainsworth contributed to attachment theory by providing empirical support through natural observation and experimental research (Ainsworth, 1967; Ainsworth, Blehar, Waters, & Wall, 1978). She also utilised these behavioural systems in explaining, and later categorising, her observations. The underlying control system for Ainsworth's "using the mother as a secure base for exploration", which is more evident around 12 months of age, is based on observations on these four behavioural systems activated in a dynamic way and within an equilibrium. When attachment and/or wariness/fear behavioural systems are minimally activated, sociability and exploration systems can easily be activated, therefore become observable. Activation of the wariness/fear system serves as a termination condition for the exploration and/or sociability systems and coincidentally as an activating condition for the attachment behavioural system. Therefore, when the fear/wariness behavioural system is activated, the attachment system is also activated and therefore exploration and sociability are inhibited. Since human infants are born physically and neurologically primitive and the majority of the motor development occurs after birth (Simpson, 1999), the formation of organised attachment behaviours continues through the first three years of life, in four phases (Bowlby, 1969).

Normative Development of Sleep and Attachment over the First Two Years of Life

The development of both sleep and attachment are ongoing life-time processes (Blampied & Bootzin, 2013; Sroufe et al., 2005). Attachment security and ISD, however, tend to develop during the first two years of life (Byars, Yolton, Rausch, Lanphear, & Beebe, 2012; Marvin, Britner, & Russell, 2016). In addition, change and maturation in both sleep and attachment in infancy appear to occur concurrently and goes in line with the timing of four phases of attachment development as suggested by Bowlby (1969). Therefore, in this section, the normative development of sleep and attachment are summarised under the four age phases, namely, birth to 12 weeks, 3 to 6 months, 6 to 12 months, and 12 months to age 3 years.

Birth to 12 weeks.

Sleep. During the first months of life, infants spend most of their time (14 to 17 hours) asleep with cycles of three to four hours (Galland, Taylor, Elder, & Herbison, 2012; Hirshkowitz et al., 2015). The circadian rhythm begins to emerge around two to three months, which is responsible for the regulation of sleep-wake transitions and works as a biological clock (Anders, 1994). Sleep/wake cycles of infants are based on dark-light cycle, however, they may also be influenced by environmental and social cues, and hormonal activities (Davis et al., 2004a). Infant sleep goes through active, quiet and indeterminate states in equal proportions that last 50-60 minutes within one or two sleep cycles (Jenni & LeBourgeois, 2006).

Attachment. Bowlby (1969) called the first 12 weeks of life as the first phase of attachment development which is characterised by the 'existence of orientation and signalling without discriminating an attachment figure' (Ainsworth et al., 1978). During this phase, the caregiver maintains proximity and protects the infant. There are predictable outcomes from infants' perspective rather than set-goals. However, rapid changes occur in baby's auditory and visual sensory systems as well which become highly developed by 2 months (Mizukami, Kobayashi, Ishii, & Iwata, 1990). They can recognise and prefer their mother's voice, orient to and track the human face, reach, cling and grasp as well as activate and terminate crying and smiling behaviours. However, there is no internal connection between these behavioural systems yet (Marvin et al., 2016).

3 to 6 months.

Sleep. Changes in infant sleep rapidly continue until the end of the 3rd month (Henderson, France, & Blampied, 2011). Around three months, the four stages of non-REM sleep become evident but sleep state cycles remain 50-60 minutes (Anders, 1994). After 3 months, non-REM, instead of quiet sleep, begins to dominate early cycles of sleep while REM sleep, instead of quiet sleep, begins to dominate the later sleep of the night (Jenni & LeBourgeois, 2006). As REM dominates and takes 55% of the cycles (Davis et al., 2004a) infants may have one or two signalled wakings per night (Galland et al., 2012). By the end of the 4th month, 70% of infants can sleep through the night with at least six hours of longest uninterrupted sleep period (Henderson et al., 2011; Henderson, France, Owens, & Blampied, 2010).

Attachment. The second phase of attachment development begins when infants start to discriminate one particular caregiver from others to direct their attachment behaviours (Ainsworth et al., 1978). Each behavioural system of Phase 1 development become more integrated as the repertoire of attachment behaviours expand and become more complex and coordinated (Bowlby, 1969). In this phase, infants start to take the initiative to activate and terminate these behavioural systems rather than having the caregiver doing it all for them and they actively seek interaction rather than passively respond to the caregiver’s bids (Marvin et al., 2016). Individual differences also start to emerge from two months onwards such as infants who were later classified as insecure-avoidant tend begin decreasing their distress signals as their caregivers tend to hold them and attend their needs less when they cry (Isabella & Belsky, 1991; Sroufe et al., 2005).

6 to 12 months.

Sleep. As infants get older, total sleep time, number of night wakings, and number of daytime naps gradually decrease, while consolidated sleep periods and total nighttime sleep increase (Burnham, Goodlin-Jones, Gaylor, & Anders, 2002a; Galland et al., 2012; Sadeh, Mindell, Luedtke, & Wiegand, 2009). By six months, many infants can sleep uninterruptedly for 6 to 8 hours at night (Davis et al., 2004a; Henderson et al., 2011) and infants continue to gradually pass on to initiating and maintaining their sleep by increased self-soothing skills (Galland et al., 2012; Scher, Epstein, & Tirosh, 2004). Around 12 months, infants spend 11 to 14 hours of the day asleep with one or two daytime naps (Hirshkowitz et al., 2015).

Attachment. In the third phase of attachment development, separation anxiety begins; behaviours become ‘goal-corrected’ based on previous experiences with the caregivers and infants learn what to expect in the following step of their mothers’ behavioural sequences (Bowlby, 1969). Subsequently, already existing behaviours are now organised in a fashion to reach the ultimate goal of proximity maintenance (Sroufe & Waters, 1977). The organisation of these behaviours is flexible while the goal, maintaining proximity, is fixed (Bowlby, 1969).

12 months to age 3.

Sleep. From 12 months, the proportion of REM sleep decreases to almost adult quality (Burnham et al., 2002a) and sleep onset begins with non-REM rather than REM sleep (Davis et al., 2004a). The physiological need for sleep gradually decreases to 13 hours per day by age two and 12 hours per day by age three, although the presence of day naps vary individually. Up to 30 minutes of sleep latency at bedtime, one night waking up to 20 minutes, and at least 84% of sleep efficiency (ratio of total sleep time to time in bed) are considered as normative for children aged 2 to 3 years (Ohayon et al., 2017).

Attachment. Phase 3 of attachment development continues until the age of three with minor changes in how children display their attachment behaviours (Bowlby, 1969, 1982). With the developments in cognitive and motor skills (Simpson, 1999), infants become mobile at the end of the first year of life which enables the active initiation of proximity seeking behaviour, such as following the mother when leaving, and contact maintenance, such as grasping mothers' legs (Ainsworth et al., 1978). Infants also become more active in their exploration and socialisation with the emergence of locomotion skills which also increases the perceived danger. The primary caregiver becomes the secure base to go about and do exploration from and come back to when there is need for protection and comfort. Thus, the individual differences in the organisation of attachment behaviours become observable and measurable both in a natural setting (Waters & Deane, 1985) and in an experimental condition (Ainsworth et al., 1978).

As children become socially more adaptive and their language skills, emotional regulation, and executive functioning increase by the end of the second year of life, the strength of observed proximity seeking and contact maintaining behaviours tend to decrease and can only be observed in more restricted situations such as an increased level of danger (Schneider-Rosen, 1990). Bowlby (1982) suggested that this change is very similar to the ones observed with primates in which young primates were pushed away by their mothers and encouraged to eat other food instead of being breastfed. For human toddlers, Bowlby explains this as an outcome of repeated experiences of the mother's leaving and coming back and developing the internal working models of their relationship with the primary caregiver, more of an outcome of information processing and maturation at the cognitive level. Bowlby called the development of internal working models Phase 4 of attachment development (Bowlby, 1969; Marvin et al., 2016).

Individual Differences in Sleep and Attachment

The end of the first year of life, seems to be an essential time for both sleep and attachment development as both attachment insecurity and secondary or persistent sleep disturbances can be detected and measured during this period. Individual differences in attachment patterns were defined from the outcomes of an experimental study run by Ainsworth and colleagues with 1-year-old infants as attachment behaviours are at their peak and readily observable (Ainsworth et al., 1978). Individual differences in sleep disturbances were suggested to have three categories based on the time of onset age and 12 months is when an infant may have a persistent sleep problem or may newly develop one (France & Blampied, 1999). Simultaneously, an increase in night wakings around 9 to 12 months was detected in longitudinal studies on normative sleep development (Bruni, Baumgartner, Sette, & Ancona, 2014; Goodlin-Jones et al., 2001; Scher et al., 2004). Although, this may not necessarily indicate a relationship between sleep and attachment development (Karraker, 2008), it is still an interesting coincidence.

In this section, first, individual differences in sleep are explained with developmental trajectories followed by definition, types, prevalence and suggested mechanisms of ISD. Second, individual differences in attachment are explained with attachment patterns, disorganisation and disorders of attachment, and suggested mechanisms of developing attachment patterns.

The developmental trajectory of sleep. The adjustment of the sleep pattern to familial and culturally determined sleep practices is the ultimate developmental goal of sleep regulation from infancy to childhood (Blampied & France, 1993). Regardless of the cultural norms and expectations, at some point in time, the individual would be expected to fall asleep and go back to sleep in between sleep cycles without receiving parental assistance (Mindell, Sadeh, Wiegand, How, & Goh, 2010). Some children would be naturally inclined to do so from early on and some others may take longer to complete the transition. Accordingly, longitudinal studies indicate a normative pattern of lengthening in nighttime sleep through infancy in two distinct trajectories emerging from early months of life.

According to the review by Henderson et al. (2011) and longitudinal study by Henderson et al. (2010), the two trajectories of sleep patterns begin to emerge at two months of age. The difference between the longest sleep period (longest period of sustained sleep) as recorded by an objective measure, and the longest self-regulated sleep period (longest period of sleep, broken only by silent arousal and resumption of sleep), based on parental records of nighttime signalling, begins to get larger for some infants and remains the same for some others, meaning these latter infants continue signalling every time a sleep cycle is over. For most infants, sleeping through the night (between 24.00-5.00) is achieved by three months (Burnham et al., 2002a; Henderson et al., 2010). By five months, 53% of infants were sleeping around the same time as the other household members. Between 6-9 months the changes slowed down and the durations showed only a small increase. At 12 months, 73% of infants could sleep for at least eight hours uninterrupted and concurrently with the other household members. On the other hand, 28% of infants from birth to 12 months did not sleep uninterruptedly even for five hours during the night.

In accordance with these findings, Weinraub et al. (2012) identified two trajectories of changes in night waking frequencies per week. In this birth cohort, which was followed from birth to 3 years, 66% of children maintained one waking per week from six months to age three while 34% showed more gradual decrease until 18 months to reach a 1-awakening-per-week level of frequency. At 15 months 12% of infants were still waking every night per week and this rate dropped to 8.96% at 24 months. In a study with a large Australian sample (Williams, Nicholson, Walker, & Berthelsen, 2016) similar patterns were observed (69% vs 31%) from eight months to six years of age.

Although the trajectory of ~30% of infants described above is normative, a problem is also defined for some of those who develop through this pathway. A problem is defined when there is a complaint (Blampied & France, 1993), when the pattern does not fit in the cultural norms or familial expectations (Jenni & O'Connor, 2005), and/or when it causes distress and long term consequences to the individual and other family members (Sadeh, Mindell, & Owens, 2011; Sadeh, Mindell, & Rivera, 2011).

Infant Sleep Disturbance (ISD).

Definition. Frequent night wakings and sleep-onset difficulties are suggested to continue to be one of the major problems parents articulate in their paediatric visits (Anders, Goodlin-Jones, & Sadeh, 2000; Byars et al., 2012; Meltzer, Johnson, Crosette, Ramos, & Mindell, 2010; Sadeh et al., 2009). Self-soothing failure, frequent night wakings, problems with settling to sleep and maintaining sleep through the night are defined as Infant Sleep Disturbance (ISD) (Anders et al., 2000; France, Blampied, & Henderson, 2003; Sadeh, Tikotzky, & Scher, 2010). There are many different ways an infant can display a disturbance in their sleep (Davis, Parker, & Montgomery, 2004b). An infant may have many manifestations of ISD at the same time or just one of them such as signalled night wakings (Sadeh, 1996). Infants with ISD usually signal their night wakings more frequently than others or it takes them longer to initiate sleep at the first bedtime (Anders et al., 2000; Byars et al., 2012; France & Blampied, 1999).

ISD can also be defined and identified by either an objective criterion or by a subjective criterion, usually mothers’ perception of their infants’ sleep (Byars et al., 2012). Studies usually take an objective criterion for research purposes (Henderson, 2001) and have an operational definition of ISD such as the one that was established by Richman (1981). In these criteria, ISD is defined as an infant having settling or waking problems five or more nights per week and at least one of the following: take more than 30 minutes to settle, wake three or more times per night, awaking for more than 20 minutes during night, sleeping in parent's bed because upset. For some infants who meet an objective criteria for having an ISD, parents may not consider their infants' sleep as a problem and some infants who do not meet the objective criteria may still be considered as having an ISD according to their parents (Morrell, 1999b). Therefore mothers' perception of their infants' sleep as a problem is suggested to be a sufficient criterion especially in clinical practice (Morrell, 1999a).

Prevalence. Across cultures, about 10 to 30% of 6 to 24 months old infants are reported by their mothers to have ISD (Teng, Bartle, Sadeh, & Mindell, 2012); including 29.9% of infants in New Zealand (Mindell, Sadeh, Wiegand, et al., 2010). Kocevska et al. (2017) reported that about half of children identified as having ISD in infancy continued having sleep problems through the age of six years.

Types of ISD based on the time of onset age. France and Blampied (1999) suggested that there are three processes of ISD development. Some infants are suggested to begin their lives with sleep disturbances owing to their physiological or constitutional tendencies. During the first phase, the infant needs to learn to initiate sleep without parental involvement, however, these infants may not be able to learn this during the first three months and continue to signal their night wakings or take long time to settle to sleep. These infants may also learn self-soothing by three months however, if sleep disturbance continues through six months and infants still display difficulties with settling to sleep and/or frequent night wakings, then infants are considered to move to the second phase and are identified as having primary ISD.

Some infants, although they may have already gained self-soothing skills, may begin having difficulties with initiating and maintaining their sleep after 12 months, from disruptions such as a sickness or birth of a sibling and these may persist into childhood (O'Callaghan et al., 2010). In this case it is called secondary ISD and may affect 19-50% of families (Blampied & Bootzin, 2013).

Suggested mechanisms of ISD. There are two major models which set out to explain the mechanisms of emergence and persistence of ISD through infancy and toddlerhood, namely, the transactional model, first suggested by Sadeh and Anders (1993) and further elaborated in Sadeh et al. (2010); and the behavioural model suggested by France and Blampied (1993; 1999). According to the transactional model, the bidirectional influences of intrinsic, proximal, and distal factors affect the parent-infant dyads and facilitate the emergence and persistence of ISD. Parents' beliefs, expectations, emotions and behaviours which are related to their infants' sleep are influenced by their environmental and socio-cultural context in distal factors; their own developmental history, psychopathology, separation anxiety and attachment in proximal; and their infants' age, developmental characteristics and sleep pattern in intrinsic factors. In return, infants' sleep is influenced by their constitutional and physiological characteristics such as fussy/difficult temperament or the level of crying, medical factors, and their relationship with their parents, especially, parental interactive behaviours (Sadeh & Anders, 1993; Sadeh et al., 2010).

The behavioural model provides an in-depth explanation for the mechanisms of the bidirectional influences of parental interactive behaviours (identified in the first model) at nighttime and the pattern of infants' sleep-related behaviours (Blampied & France, 1993; France & Blampied, 1999; France et al., 2003). According to this model, the state of sleep is a natural reinforcer for both parent and infant, however, the antecedents of falling asleep may not provide the opportunity for the infant to develop the skill to achieve behavioural quietude without outside assistance. The complex chains of behaviours leading to falling asleep for an infant with ISD is typically described by a coercive behaviour trap (Patterson, 1976) where parents may avoid their infants' cry and distressed behaviours and infants may avoid unfamiliar, distressing circumstances of waking up (or being awake) and not being able to fall back to sleep without predicted and reinforced contingencies. For example, following an awakening at night the infant cries and signals the parents and the parent responds in a way that reinforces the intensity by stimulating the infant and eventually ends with the onset of sleep. If when the infant wakes up and cries again, the parents do not respond (in an attempt to “break the cycle”), this leads to a reduction in reinforcement and, the infant cries louder and shows more distressed behaviours which leads again to parents’ immediate response. The dyad enter the escape-avoidance (or coercion) trap where each acts to decrease the aversive responses to their behaviour. In this case, the overstimulating and inconsistent parental nighttime behaviours are also considered as an outcome of previous experiences and environmental influences. Therefore perspectives of these two models to describe mechanisms of ISD are complementary to each other.

The quality of attachment relationship. Although every infant is biologically predisposed to form a tie to a caregiver, depending on the contextual factors, there are individual differences in the quality of this relationship (Simpson, 1999). The empirical data from studies of Ainsworth (1967) resulted in a division into secure and insecure attachment. The laboratory procedure to observe and classify the individual differences of attachment organisations in 12 to 18 months old infants (Ainsworth et al., 1978), namely, the Strange Situation Procedure has become the standard measure of attachment (Solomon & George, 2008).

There are four interactive attachment behaviours observed and scored during SSP, each of which represent one aspect of the organisation of behavioural systems in a goal-corrected way. These are proximity seeking, contact maintenance, (contact) resistance and (proximity) avoidance (Ainsworth et al., 1978). Proximity seeking refers to infants’ active initiation of physical proximity with their caregivers. The scoring is based on how active the infant is to seek proximity with and comfort from the caregiver. Contact maintenance refers to infants’ active initiative to maintain the physical contact during reunion episodes.

Resistance refers to infants' display of anger and resistance while in contact with their caregivers during a reunion. Avoidance is scored for infants who actively ignore caregivers' bids for initiating contact and proximity or simply ignore their caregiver during a reunion episode instead of actively seeking contact and proximity. Based on scores nominated in these behavioural variables, infants receive a sub-category classification within secure or insecure patterns.

Secure attachment. The global, population-based prevalence of secure attachment is reported to be between 50-80% based on results from studies using SSP in countries from each continent (Mesman, van IJzendoorn, & Sagi-Schwartz, 2016). A secure infant is characterised by specific behavioural organisations such as protest at separation, greeting a figure with enthusiasm, showing differential stopping of crying or differential smiling, body posture, vocalisation and/or following towards the caregiver at a reunion after a short duration of separation while absence of anger, petulance or withholding contact (Ainsworth et al., 1978; Bowlby, 1969). Secure infants can explore the environment freely in a caregiver's presence. As their distress increases, their ability to use the caregiver as a resource for comfort and reassurance also increases and this active initiation of comfort seeking should be effective (Sroufe & Waters, 1977).

Infants with a secure pattern, depending on the level of avoidance and contact maintenance behaviours they displayed at reunion episodes, are divided into 4 sub-categories (B1, B2, B3 and B4). While infants with the B1 category receive the highest scores in avoidance and the lowest scores on contact maintenance, when compared to other secure infants; infants with the B4 category receive the lowest avoidance scores and highest contact maintenance scores (Ainsworth et al., 1978). Infants in the B4 category are considered to be more 'dependent' as compared to infants with B1 to B3 categories owing to their relatively higher scores on resistance behaviour at reunion episodes of SSP and longer cry durations at SSP separation episodes (Thompson & Lamb, 1984:Zentall, 2012 #470).

Insecure attachment. Infants with insecure attachment were originally divided into 2 categories by Ainsworth et al. (1978): avoidant (A1 and A2) and ambivalent/resistant patterns (C1 and C2). Today, these categories, along with secure sub-categories, are considered as the normative (or organised) attachment classification system (ABC) (Solomon & George, 2016).

Infants with an avoidant attachment pattern who globally comprise up to 23% of the population (Mesman et al., 2016; van IJzendoorn & Kroonenberg, 1988) are described as showing no sign of distress when they are left alone or with a stranger, unresponsiveness to caregivers return at reunion, and minimum engagement with the mother, such as not looking at the mother while being held. Infants with an avoidant attachment pattern tend to receive the highest scores on proximity avoidance and lowest scores on contact maintenance. Depending on the proximity seeking behaviours they display, there are two sub-types being A1 and A2.

Infants with an ambivalent/resistant attachment pattern (5-33% of the population) are described as being constantly irritable at the mothers' presence and during separation, show exaggerated proximity seeking or contact maintenance behaviours while also showing elevated resistance behaviours towards their mothers and displaying anger simultaneously. Infants with this pattern of attachment tend to receive the highest scores on resistance to contact and lowest scores on avoidance. Depending on the degree of anger and ambivalence displayed during reunion episodes, they may receive C1 or C2 subtypes. This pattern of attachment is also called "preoccupied" as infants' active exploration and play skills are highly compromised by the aim of focusing all their attention to their mothers' behaviours (Cassidy & Berlin, 1994; Weinfield, Sroufe, Egeland, & Carlson, 2008).

Disorganised attachment and attachment disorders. When the four key behavioural systems related to attachment formation, namely, attachment, fear/wariness, exploration, and sociability (and anger) do not exhibit equilibrium in their organisation, the disorganised/disoriented attachment pattern and attachment disorders are defined, based on the extremity of the difficulties displayed by infants and toddlers (American Psychiatric Association, 2013; Solomon, Duschinsky, Bakkum, & Schuengel, 2017). Disorganised behaviours and a disorganised attachment pattern (The D classification) were later added to the original classification system. These were described by Main and Solomon (1986) in order to classify out-of-context behaviours observed during SSP which are suggested to disrupt the organisation of attachment behaviours due to possible neglect, abuse or fear-inducing responses or unresolved trauma of caregivers (Carlson, 1998; Hesse & Main, 2000).

The D classification comprises 15-20% of the general population with an over-representation in the welfare population (Solomon & George, 2016). The disorganised attachment category is assigned after assigning infants into organised ABC categories and it applies if odd-looking or out-of-context behaviours of infants are observed when the mother is in the room with the child during the SSP. These behaviours were categorised into seven indices which were 'sequential displays of contradictory behaviour', 'simultaneous display of contradictory behaviour', 'undirected, misdirected, or incomplete movements', stereotypies, mistimed movements, and anomalous postures', freezing or stilling', 'display of apprehension of the caregiver' and 'overt signs of disorientation or disorganisation'(Main & Solomon, 1990).

When the environment is extremely different from an environment for 'evolutionary adaptedness' (Bowlby, 1969), including events such as extreme neglect or social deprivation, rearing in unusual settings, and repeated changes of primary caregiver, reactive or disinhibited attachment disorders may develop and these are defined in the Diagnostic and

Statistical Manual of Mental Disorders, DSM-V (American Psychiatric Association, 2013). Attachment disorganisation and disorders of attachment are beyond the scope of this study as the target population is the one which is close to the 'evolutionary adaptedness', that is, children living with at least one parent with the least risk factors. Therefore, the focus in the following sections is on normative attachment insecurity rather than the disorganisation and/or disorders of attachment.

Suggested mechanisms of insecure attachment development. The mechanism of secure attachment as described by Ainsworth et al. (1978) using the control systems model of Bowlby (1982) suggest that, when activation of fear/wariness and attachment behavioural systems are low, sociability and exploration are highly activated. When fear/wariness is activated, attachment behaviours are also activated therefore exploration and sociability diminish until the fear/wariness system is deactivated again after the infant reached the predicted outcome which is feeling safe and comforted. When fear/wariness is activated in an infant with avoidant pattern, however, the exploration and sociability with the stranger becomes activated instead of attachment behaviours and these become even more elevated as the stress increases. For an infant with ambivalent/resistant pattern, fear/wariness easily activates attachment behaviours in the expense of diminished exploration and sociability behavioural systems and the attachment behaviours accompanied by anger behaviours escalate with the increase in perceived stress.

Ainsworth's (1967, 1985) observational research on mother-infant interactions suggested that the development of the organisation in these behavioural systems were mostly an outcome of the quality of caregiving which is called maternal sensitivity, through the first year of life. However, a later meta-analysis revealed that the quality of caregiving, specifically maternal sensitivity, had a very small effect size on the quality of infant attachment (De Wolff & van IJzendoorn, 1997). In order to understand the complex mechanisms of the development of attachment insecurity, the principles of developmental psychopathology has been employed in longitudinal research projects in the United States such as the Minnesota Longitudinal Study of Risk and Adaptation (Sroufe et al., 2005) or the National Institute of Child Health and Human Development (NICDH) Study of Early Child Care (NICHD Early Child Care Research Network, 1997). The developmental cascading models emerging from such longitudinal studies are still evolving with more data on constructs such as the neuropsychological impacts of chronic stress in infancy (Beijers, Riksen-Walraven, Sebesta, & de Weerth, 2017) or the differential susceptibility paradigm emphasising the fit between gene-environment interactions (B. J. Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2011; Fearon & Roisman, 2017).

Effects of Sleep and Attachment on Later Functioning

The qualities of both sleep and attachment are independently associated with later functioning of children. Having a secure attachment pattern and a healthy development of sleep are demonstrated to enhance children's adaptive functioning and self-regulation (Bernier, Beauchamp, Bouvette-Turcot, Carlson, & Carrier, 2013; Bernier, Carlson, Bordeleau, & Carrier, 2010; Calkins & Leerkes, 2011; Keller, El-Sheikh, & Buckhalt, 2008; Sroufe et al., 2005; Vaughn et al., 2011; Vaughn, Elmore-Staton, Shin, & El-Sheikh, 2015; Weinfield et al., 2008).

Infant sleep disturbance, however, is associated with poorer later development of infants' cognitive and behavioural skills (Sadeh et al., 2015; Sadeh, Mindell, & Owens, 2011). Studies indicate that especially the persistency of ISD into childhood may disrupt the architecture of sleep, negatively affect the development of grey matter in the brain, increase the likelihood of having emotional, behavioural, and attentional problems, increase the risk of obesity; and may decrease academic achievement of children (Byars et al., 2012; Keller et al., 2008; Kocevska et al., 2017; Nielsen, Danielsen, & Sørensen, 2011; Sadeh, Mindell, & Owens, 2011; Vaughn et al., 2011; Williams, Berthelsen, Walker, & Nicholson, 2017).

Insecure attachment in infancy is associated with having lower levels of competence in social and peer relationships and higher levels of internalising and externalising problems in childhood when compared to children with secure attachment in infancy (Fearon, Bakermans-Kranenburg, van IJzendoorn, Lapsley, & Roisman, 2010; Groh, Fearon, van IJzendoorn, Bakermans-Kranenburg, & Roisman, 2017; Groh, Roisman, van IJzendoorn, Bakermans-Kranenburg, & Fearon, 2012). Among insecure attachment patterns, having an ambivalent/resistant pattern is further considered as a risk factor for having delayed developmental milestones, having problems with executive functioning, and obesity (Anderson & Whitaker, 2011; Erickson, Sroufe, & Egeland, 1985; Sroufe et al., 2005; Weinfield et al., 2008).

Factors Concurrently Contributing to the Development of ISD and Attachment Insecurity

ISD and attachment insecurity are both suggested to be products of interactions between environmental and individual factors (Belsky & Fearon, 2008; France & Blampied, 1999; Sadeh et al., 2010) and there seem to be some common variables, which independently affect both processes. These common factors can be generalised under infant (ontogenic), parent (proximal), and environmental (distal) levels. Possible associations between ISD and attachment insecurity, therefore, cannot be considered without the influence of these common variables and their reciprocal interactions.

Infant level.

Negative emotionality. Both attachment and sleep have been linked to temperamental biases of the infant. Especially, negative emotionality seems to play an important role in the development of both ISD and insecure-ambivalent attachment pattern (Belsky & Fearon, 2008; Groh et al., 2017). Negative emotionality, or difficult temperament (Bates, 1980), is defined as a combination of several temperamental biases defined in the temperament literature such as high reactivity and irritability, anger and fear, low malleability and rhythmicity, high frequency of crying and fussiness and low adaptability and mood (Blair, 2002; Fish, Stifter, & Belsky, 1991; France & Blampied, 1999; NICHD Early Child Care Research Network, 2004).

In sleep literature, the reciprocal effects of infants' temperament and ISD have been established (Ednick et al., 2009). Studies suggested that infants with ISD are perceived by their parents as having higher levels of difficult temperament (Keener, Zeanah, & Anders, 1988; Scher, 2001a) and infants with objectively measured negative emotionality have poorer sleep quality (De Marcas, Soffer-Dudek, Dollberg, & Bar-Haim, 2015; DeLeon & Karraker, 2007; France & Blampied, 1999). Moreover, the perception of parents about their sleep disturbed infants' temperament tended to change after a sleep intervention to more positive qualities (France, 1992) which may indicate that (a) parents of infants with sleep disturbance may be biased in their perception of their infants' temperament and/or (b) difficult temperament might indeed have changed. How reliable parental reports can be is a general concern in the literature and makes it even more questionable in the case of ISD which may have a negative impact on overall family wellbeing (Goldsmith & Hewitt, 2003; Pauli-Pott, Mertesacker, Bade, Haverkock, & Beckmann, 2003; Sadeh, Mindell, & Owens, 2011; Saudino, 2003a, 2003b). On the other hand, although temperament is assumed to be a lifetime trait which should stay stable in time (Kagan, 2010), negative emotionality may indeed have a potential to change in relation to changes in the environment (Fish et al., 1991). Using both subjective and objective measures of negative emotionality is needed to optimise the information on continuity of this temperamental bias.

Contrary to sleep literature, the role of temperament has been a debated topic for several years in the attachment literature (van IJzendoorn & Bakermans-Kranenburg, 2012). There have been different perspectives on possible associations varying in a spectrum from acknowledging attachment patterns as purely manifestations of temperamental biases (Kagan, 2010) to regarding temperament and attachment as two distinct constructs with no associations (Sroufe, 1985). However, studies on predicting sub-types of attachment insecurity (A vs C) and sub-categories of attachment classifications (e.g. B1 vs B4) through objective measures of temperamental biases indicated a relationship between high negative emotionality of the infant and low sensitivity of the mother predicting a later insecure-ambivalent attachment pattern (Belsky & Fearon, 2008; Belsky & Rovine, 1987; Kochanska & Coy, 2002; Mangelsdorf, McHale, Diener, Goldstein, & Lehn, 2000; Mills-Koonce, Propper, & Barnett, 2012; Sroufe, 2005). In recent years the differential susceptibility paradigm became more dominant in the discussion and suggests that infants with negative emotionality are more prone to changes in the quality of caregiving but also, in return, they are the ones who benefit the most from relationship-based interventions (Belsky & Fearon, 2008; Crockenberg & Smith, 2002; van IJzendoorn & Bakermans-Kranenburg, 2012).

Parent level. The primary caregiver, who is mostly the mother, appears to play a major role in the development of both ISD and attachment insecurity (Simpson, 1999; Zentall, Braungart-Rieker, Ekas, & Lickenbrock, 2012). Even though there may be other caregivers around the infant, the primary caregiver, tends to be at the top of the hierarchy of attachment figures (Belsky & Fearon, 2008; Marvin & Britner, 2008). For ISD, there are studies indicating that mothers tend to continue taking the responsibility of attending to their children’s needs at nighttime as well (Sadeh, Mindell, & Rivera, 2011; Scher & Asher, 2004; Zentall et al., 2012). There are several parent-related variables associated with the development of ISD and attachment insecurity. In this section the common factors to both ISD and attachment insecurity are described.

Parental characteristics. Longitudinal studies with birth cohorts suggested that the depression experienced by the primary caregiver not only impacts the wellbeing of the person who experiences it, but also has a long term impact on the behavioural, emotional functioning and wellbeing of children (Armitage et al., 2009; Sroufe et al., 2005). Studies on the attachment patterns and parental characteristics suggest that infants of mothers with long term depression are more likely to have insecure attachment, especially an avoidant or disorganised pattern (Martins & Gaffan, 2000; Sroufe et al., 2005). Whereas the link between maternal depression and ISD has been reciprocal as maternal depression has not only been the precursor of ISD but also is described as one of the outcomes of having an infant with ISD (Giallo, Rose, & Vittorino, 2011; Hairston, Solnik-Menilo, Deviri, & Handelzalts, 2016; Martin, Hiscock, Hardy, Davey, & Wake, 2007; Meltzer & Mindell, 2007; Teti & Crosby, 2012; Warren, Howe, Simmens, & Dahl, 2006).

Further, parents' own attachment patterns measured by the adult attachment interview (AAI) as dismissive and pre-occupied, which are equivalent to avoidant and ambivalent/resistant attachment patterns of infancy, has an association with infants' insecure attachment patterns (McMahon, Barnett, Kowalenko, & Tennant, 2006; Steele, Steele, & Fonagy, 1996). Similarly, a study by Benoit, Zeanah, Boucher, and Minde (1992) reported that parents who applied to a clinic for their infants' sleep problems tended to have dismissing and/or preoccupied attachment patterns. Further studies have supported this result (Cohenca-Shiby & Schonbach-Medina, 2013; Hairston et al., 2016) however the Benoit et al study is still the only one reporting the standard AAI data.

In addition, mothers' own separation anxiety from their children (Belsky & Fearon, 2008; Sadeh et al., 2010; Scher, 2008; Scher & Mayseless, 2000), and problems with their cognitions about their child's sleep (Loutzenhiser, Ahlquist, & Hoffman, 2011; Morrell, 1999b; Sadeh, Flint-Ofir, Tirosh, & Tikotzky, 2007; Tikotzky & Sadeh, 2009) or cognitions which help them to see their child as a separate entity (Benoit, Zeanah, Parker, Nicholson, & Coolbear, 1997; Dollberg, Feldman, & Keren, 2010; Hawkins, Madigan, Moran, & Pederson, 2015; Slade, 2005) appear to be common factors to predict ISD or insecure attachment.

Parental Behaviours. In the development of ISD, certain parental behaviours are repeatedly demonstrated to play a pioneer role (Sadeh et al., 2010) and in attachment literature, the quality of parental behaviours rather than the actual behaviours are suggested to be crucial (Belsky & Fearon, 2008). In either case, behaviours displayed by an individual cannot be independent from the other person that the individual is engaging with, in this case, the infant (France & Blampied, 1999). Therefore, parental behaviours in relation to infants' behaviours and/or temperamental biases need to be considered in this section. There is a growing amount of evidence that caregiving sensitivity of mothers, which is suggested to be the most important antecedent of attachment patterns, is dependent upon infants' temperamental biases and these two should be considered together rather than individually (Gartstein & Iverson, 2014; Kochanska & Coy, 2002; Mangelsdorf et al., 2000).

Parental behaviours which are repeatedly associated with having ISD can be summarised as putting infants to bed already asleep, being present at sleep onset, using or interchanging a large variety of management techniques, feeding, and overstimulating at bedtime (Burnham et al., 2002a; Goodlin-Jones et al., 2001; Mindell, Meltzer, Carskadon, & Chervin, 2009; Mindell, Sadeh, Kohyama, & How, 2010; Ramamurthy et al., 2012; Sadeh et al., 2009). Sadeh and Anders (1993) considered bedtime interactions and limit-setting difficulties within the parent-infant mediating context of their transactional model (Sadeh et al., 2010).

In attachment development, the quality of parenting, rather than the actual behaviours is emphasised. For instance, in a longitudinal study, mothers of infants who were later classified as having insecure-avoidant attachment were observed to hold their babies as frequently as mothers of infants with secure and other insecure attachment patterns however, they tended to not hold their babies when they signalled their distress (Sroufe et al., 2005). One aspect of the quality of caregiving which is called maternal sensitivity, is one of the most important antecedents of attachment patterns (Belsky & Fearon, 2008), and its effects are in a bidirectional relationship with the infant's negative emotionality (De Wolff & van IJzendoorn, 1997; Lickenbrock & Braungart-Rieker, 2015). Maternal sensitivity is therefore an interactional concept, basically, based on how parents behave and how sensitive they are to meeting their infants' both physical and psychological needs. It may further be defined as being in synchrony with the infant, responsive to infants' needs, reading and understanding infants' signals in the right way and immediately acting in the appropriate way to fulfil them (Ainsworth, 1985). Mothers of infants who have an insecure attachment pattern were repeatedly demonstrated to be less appropriately available and sensitive to their infants' needs when compared to mothers of infants with secure attachment (De Wolff & van IJzendoorn, 1997).

In terms of maternal sensitivity, there seems to be a similarity between the attachment and sleep literature, that is, in the sleep literature, mothers of infants with ISD are generally described as inconsistent in their nighttime behaviours, and intrusive in a way that undermines their infants' self-soothing skills (DeGangi, 2000; Sadeh & Anders, 1993; Sadeh et al., 2010). Mothers of infants with an ambivalent/resistant attachment pattern are also described as intrusive, inconsistent and less available and sensitive to their infants' cues during daytime interactions (Sroufe et al., 2005). More precisely, mothers of infants with ambivalent/resistant attachment are described as unavailable when their infants actually had a need and overinvolved or even intrusive when their infants did not need it (Cassidy & Berlin, 1994).

Despite these seeming similarities, the evidence on the relationship between ISD and maternal sensitivity is mixed. Normative development of sleep and maternal sensitivity in one-year-olds were not found to be associated (Scher, 2001b), however Bordeleau, Bernier, and Carrier (2012) indicated that maternal sensitivity at 12 months significantly predicted good quality of sleep at preschool years. In addition, an association between lower scores on maternal sensitivity and perceived ISD was indicated (Cramer et al., 1990; Priddis, 2009; Robert-Tissot et al., 1996) while another study found a relationship between the continuing night wakings trajectory of sleep and higher maternal sensitivity during the first 3 years of life (Weinraub et al., 2012). These mixed results may point to a difference in parents' night time and day time interactions with their infants.

The nature of parental daytime interactions and nighttime interactions with their infants need to be different because the first one needs to be stimulating to encourage learning, exploration and sociability of the infants while the latter needs to be less stimulating and more encouraging of behavioural quietude to achieve the physical state needed in order to fall asleep. Teti, Kim, Mayer, and Countermine (2010) specifically measured mothers of 1 to 24 months old infants' emotional availability at night time with a re-definition of sensitivity based on the necessities of night time interaction (such as delayed responsiveness) in order to encourage infants' self-soothing skills and found that mothers with higher scores on emotional availability at nighttime perceived their infants as having fewer sleep problems and their infants objectively had fewer disruptions in settling and maintaining their sleep compared to infants with mothers who were less emotionally available at night. In a later study on the developmental trajectory of emotional availability at nighttime (Kim, Chow, Bray, & Teti, 2017), it was found that emotional availability at nighttime tended to decrease as infants get older than 1 year of age which goes in line with the behavioural mechanisms of self-soothing development in infants. Interestingly this construct was also found to be predictive of attachment security at 12 months (Kim et al., 2017).

Environmental factors. Apart from the large influence of culture on development, or even perception of ISD and attachment insecurity (Sadeh, Mindell, & Rivera, 2011; van IJzendoorn & Kroonenberg, 1988), maternal social support (Belsky & Fearon, 2008; Bernier, Bélanger, Bordeleau, & Carrier, 2013; Sroufe et al., 2005) and marital conflict (Lickenbrock & Braungart-Rieker, 2015; Rhoades et al., 2012) seem to be the commonly cited environmental associations.

Potential for Change in ISD and Attachment Insecurity

As life-long processes of attachment and sleep are in constant interaction with other factors (Blampied & Bootzin, 2013; Sroufe et al., 2005), both insecure attachment and ISD have the potential to change in time. While changes can naturally occur, they can also change through well-established interventions (France & Hudson, 1993; van IJzendoorn, Juffer, & Duyvesteyn, 1995). Both sleep and attachment interventions target parental behaviours for change in order to trigger the change in the infant. Although their theoretical orientations and techniques are different, both approaches seem to have an effect on changes in both sleep and attachment patterns.

Natural change in ISD. Natural change in ISD may occur after any age stage of its development; the first stage, which is up until three months, or after six or 12 months of age depending on environmental changes such as breastfeeding status (Mindell, Du Mond, Tanenbaum, & Gunn, 2012), or after intrinsic changes such as improvements in self-soothing skills (Scher et al., 2004) or development of a natural alignment in circadian and ultradian rhythms (Jenni & LeBourgeois, 2006). Studies show that 50 to 80% of infants with ISD are no longer defined by their parents as having a problem by the age of three and meet normative patterns (Byars et al., 2012; Kocevska et al., 2017).

Interventions to change ISD.

Behavioural sleep interventions. The sleep interventions literature is largely based on behavioural management techniques which are based on social learning theory, or coercion theory (Patterson, 1976), operant conditioning, and modern learning theory (Skinner, 2013/1969), specifically, the principles of extinction (France & Hudson, 1993). Change in infants' behaviour is targeted through changing parental behaviours first and then a change in the pattern of the sleep is expected (Mindell et al., 2006).

Behavioural sleep interventions (BSI) involve, following a functional behavioural assessment, a modification of the antecedents and consequences of falling asleep by firstly bringing bedtime behaviour chains under a discriminative stimulus control that would lead into behavioural quietude; and secondly strengthening and maintaining behaviour chains by contingencies of reinforcement (Blampied, 2013). Bringing the behaviours under a discriminative stimulus control process involves extinction which refers to the withdrawal of reinforcers which were previously reinforced. When reinforcers of a behaviour no longer occurs, this reduces the strength of the behaviour and eventually minimises the frequency of occurrence (Blampied & Bootzin, 2013). The introduction of the extinction process immediately causes the phenomenon called "the post-extinction-response-burst (PERB)" in which the behaviour occurs intensely with decreasing intervals before it disappears (France & Blampied, 2005). In the case of ISD, the PERB means infants crying stronger and for longer duration during the first 3-4 days of the intervention (Selim, France, Blampied, & Liberty, 2006). Even the modifications of behavioural sleep interventions involve a certain amount of crying (Healey, France, & Blampied, 2009) as PERB is an essential part of behaviour modification through extinction (Blampied, 2013).

Studies indicate that behavioural sleep interventions effectively improve sleep patterns of infants (France & Blampied, 2005; France & Hudson, 1990; Mindell et al., 2006; Owens, France, & Wiggs, 1999; Wilson, 2013) and improvements are maintained through childhood (Price et al., 2012; Thunstrom, 2000). Since having persistent ISD is associated with difficulties in functioning of children, implementing evidence-based interventions to reduce sleep disruptions during the first 2 years of life is suggested to prevent these problems from occurring in the long run (El-Sheikh & Buckhalt, 2015; Price et al., 2012). However, some parents of infants with ISD may not be willing to receive help, and especially, to implement a behavioural sleep intervention (Morrell, 1999b). According to Etherton, Blunden, and Hauck (2016) some parents may not want to implement a BSI for reasons such as difficulty with coping with infants' cries and different parenting beliefs that do not match with professional's suggestions. However, there is no study to date to empirically examine the characteristics of families who may not want to implement a BSI.

Secondary outcomes of Behavioural Sleep Interventions. BSIs are not only reported to improve sleep patterns of infants but may also have a positive impact on infant mental health, maternal mood and sleep-related cognitions, and family wellbeing (Črnčec et al., 2010; Eckerberg, 2004; France, 1992; Hall, Clauson, Carty, Janssen, & Saunders, 2006; Mindell et al., 2006; Morgenthaler et al., 2006). Although there are several studies on the positive impacts of behavioural sleep interventions on the general wellbeing of families, there are discussions and criticism against behavioural sleep interventions based on the assumptions of attachment theory (McKenna et al., 1993). It is claimed that interventions may damage the infant's attachment to the mother by letting the infant cry for a long time without being soothed by the mother as soon as possible, which is argued to have a risk of reducing maternal sensitivity to the infant's distress cues and making the infant feel less secure in the relationship (Blunden et al., 2011; Middlemiss, Granger, Goldberg, & Nathans, 2012).

However studies on the effects of infant daily cry and routine separation (i.e. day-care) on attachment patterns indicated that ‘benign’ neglect of daily stresses do not affect attachment patterns (van IJzendoorn & Hubbard, 2000) and in fact having rituals before and after daily separations improve infants’ coping skills with daily stress (Klein, Kraft, & Shohet, 2010).

Natural change in attachment insecurity. Although attachment patterns are generally considered as stable, they are dependent upon the stability in environmental factors which have an effect on the quality of caregiving (Lamb, 1987). Natural stability and change in attachment patterns was first observed in the sample of the Minnesota Longitudinal Study in which SSP was replicated when infants were 12 and 18 months old (Sroufe et al., 2005). Results indicated that 74% of secure infants at 12 months remained secure, 45% of infants with avoidant pattern remained avoidant and 37% of infants with ambivalent attachment remained ambivalent at 18 months and this stability was significant. However, it was also found that attachment patterns changed from insecure to secure when family stress decreased, maternal mood improved and maturity of the mother increased which in turn improved the quality of caregiving (Egeland & Farber, 1984). Many studies up to this point supported this finding with the inclusion of factors such as increase or decrease in poverty, major illness, divorce, or a marriage (Solomon & George, 2016). Recent meta-analyses on the stability of attachment patterns from infancy to adulthood also indicated that attachment patterns in infancy were moderately stable (Pinquart, Feußner, & Ahnert, 2013) although the change was evident depending on the measure used and the age of the child at the time of the first and follow up assessments. While the secure attachment pattern appeared to be more stable from infancy to adolescence, disorganised and avoidant attachment patterns seemed to be the least stable ones (Solomon & George, 2016).

Interventions to change attachment insecurity. Interventions to change attachment patterns are relationship-based (van IJzendoorn et al., 1995) and the theoretical background is

Bowlby's attachment theory (1969). In relationship-based interventions not only parental behaviour but also a change in maternal representations and cognitions are targeted to improve maternal sensitivity which is, in return, expected to improve infants' attachment security (Bernard, Meade, & Dozier, 2013). Interestingly, meta-analysis on the effectiveness of attachment interventions suggested that practices with the best outcomes on both maternal sensitivity and change in infants' attachment patterns were the ones which focused on behavioural change in parents using social learning theory principles (Bakermans-Kranenburg, van IJzendoorn, & Juffer, 2003; Bakermans-Kranenburg, van IJzendoorn, & Juffer, 2005; van IJzendoorn et al., 1995) rather than relationship-based interventions. In addition, there are also studies suggesting that behavioural interventions tend to improve the attachment pattern of infants (O'Connor, Matias, Futh, Tantam, & Scott, 2013), infant security as perceived by parents (France, 1992), and maternal sensitivity (Minde, Faucon, & Falkner, 1994).

Secondary outcomes of attachment interventions; specifically on sleep patterns. Interestingly, attachment-related interventions are suggested to improve sleep patterns of infants in clinical sleep problem groups (Cramer et al., 1990; Robert-Tissot et al., 1996) and the child welfare population (Oxford, Fleming, Nelson, Kelly, & Spieker, 2013; Spieker et al., 2012), although infant sleep was not the target primary outcome. This may be a clue to the possible relationships between these two processes.

Conclusion

In the light of the literature summarised above, one would expect the empirical studies and the theoretical suggestions on the relationship between attachment and sleep focus on these common elements between the two processes and consider each contributing factor when studying the possible aspects of this possible relationship. It is not illogical to consider a bi-directional or multi-directional (transactional) relationship between the two processes but it is also possible that both of them just happen to develop in a parallel fashion. The next chapter focuses on what the literature suggests so far and how researchers went about answering these questions.

Current Literature

The Relationship between Infant Sleep and Attachment

In this section, the current literature including studies measuring both infant sleep and attachment variables is first systematically evaluated and summarised. Next, the theoretical implications of these findings are discussed.

Systematic review of the current literature. The databases “Psych INFO”, “Psych Articles”, “Ebscho HOST”, “Web of Science”, “PubMed”, “Science Direct”, and “SCOPUS” were searched for peer-reviewed empirical articles with the keywords of “infant/toddler sleep and attachment”, “infant/toddler sleep problems and attachment”, “infant/toddler sleep and attachment security”, “infants’/toddlers’ sleep problems and attachment security/ insecurity”. The search was refined to exclude studies with adult sleep, and cross-sectional studies with school aged and older children. The meta-analysis conducted by Simard et al. (2017), a systematic review covering studies from infancy to adulthood (Adams et al., 2014), and reference lists of identified articles were further scanned for additional studies.

In addition to the age range of 0 to 5, the inclusion criteria for an exploratory or descriptive study were having any measure of infant sleep variables and any measure of attachment variables; and including outcomes of these assessment tools in the results section. Intervention studies were excluded if sleep or attachment was not measured at baseline. One study was excluded as there was no specific information in the results section about the sleep measure they used (Tharner et al., 2012). Finally 20 articles which were measuring sleep and attachment within the first five years of life were included in the literature review. Studies were grouped based on the design and timing of the sleep and attachment measures in order to demonstrate the directionality of the possible relationship. The supporting evidence from current literature and research to date is summarised in three tables addressing sleep first, then attachment, Table 1; attachment first, then sleep, Table 2; and sleep and attachment concurrently, Table 3. First, studies are systematically evaluated for the participants, methods, sleep and attachment variables, and measures used, then, the methodological quality of studies in each table is evaluated. Evidence supporting and opposing the relationship between each attachment pattern and either normative infant sleep or ISD are summarised by grouping results of studies on sleep and attachment according to their sleep variables (normative sleep patterns vs ISD) and attachment patterns (secure, insecure in general, insecure-avoidant, insecure-ambivalent/resistant, dependency, and insecure-disorganised). Finally, those with "strong" quality for each table are summarised.

The quality of the studies was analysed using the "Standard quality assessment criteria for evaluating primary research papers from a variety of fields" developed by Kmet, Lee, and Cook (2004) which includes a 14-item checklist with a 3-point scale for each criterion (2 = yes, 1 = partial, 0 = no, N/A = not applicable). The quality of the research paper is determined by dividing the total score with the possible total sum of scores and can be converted to a percentage of quality. Percentages then categorised into 'strong' (>80%), 'good' (70%-80%), 'adequate' (50%-69%), and 'limited' (≤50%). Studies with percentages below 50 indicate poor quality. Despite the previously published systematic review and the meta-analysis, using the majority of the selected articles, the quality assessment has not previously been reported.

Participants. The number of participants in the reviewed studies ranged from 34 to 1364 with an age range of birth to 5 years. All studies except two were conducted with a sample derived from a normative population. One of those two studies was conducted with preterm infants (Schwichtenberg, Shah, & Poehlmann, 2013) and the other study was conducted with infants of mothers with a history of mental health problems (Seifer, Sameroff, Dickstein, Hayden, & Schiller, 1996). Three studies used a sub-sample of the same longitudinal study but used different criteria for inclusion (McNamara, Belsky, & Fearon, 2003; Troxel, Trentacosta, Forbes, & Campbell, 2013; Weinraub et al., 2012).

Out of 20 studies, only six studies (30%) had ISD as a grouping variable and 14 studies (70%) were conducted on normative sleep patterns. In defining an ISD group, three studies used maternal report (Ding, Xu, Wang, Li, & Wang, 2014; Scher, 2001a; Troxel et al., 2013), one study used objective criteria (McNamara et al., 2003) and two studies used both maternal report and objective criteria (Morrell & Steele, 2003; Scher & Asher, 2004).

Designs. Sixteen studies employed a prospective longitudinal design with 2 to 4 time-points of sleep assessment. One study was a case-control design with 1-year follow-up and three studies had a cross-sectional design. Eight of the longitudinal studies measured sleep first, then attachment (Table 1), six studies measured attachment first, then sleep (Table 2), and six studies measured sleep and attachment concurrently (Table 3). Only one study measured attachment at two time points however, the relationship between sleep and attachment results were only reported for the first attachment measure (Ding et al., 2014).

Measures and variables. The gold standard to measure sleep is considered to be polysomnography but this is impractical for use with young children in natural environments. Therefore, the optimal way to measure infant sleep is suggested to be a combination of sleep diary and an objective measure such as an actigraphy or videosomnography (Sadeh, 2015). In studies on sleep and attachment, there were a variety of measures and variables used for sleep assessment. There were only nine studies using some combination of maternal report and an objective sleep measure, eight of them being actigraphy. Eight studies (40%) used retrospective maternal report, such as a questionnaire or a checklist, while two studies used only prospective maternal report (i.e. Sleep Diary) and one study used both retrospective and prospective maternal reports on sleep.

Further, a variety of sleep variables were chosen by the assessed studies such as number of night wakings per night, per week, or number of wakings longer than 15 minutes. Objective sleep variables had more consistency among studies, which usually considered sleep efficiency as measured by actigraphy. Two studies were unique in terms of their sleep variables as they tested the effects of the place of sleep (i.e. communal, solitary, or bed-sharing) on the attachment patterns (Mileva-Seitz et al., 2016; Sagi, van IJzendoorn, Aviezer, Donnell, & Mayseless, 1994).

For the assessment of attachment quality, the majority of studies (65%) employed the Strange Situation Procedure. The others were the Attachment Q-Sort (AQS) (Waters & Deane, 1985) and the Preschool Assessment of Attachment tools. The AQS is the equivalent of the SSP for home setting observational assessment and it provides a continuous security score, higher scores indicating more security in attachment (Solomon & George, 2016). Scher and Asher (2004) used the maternal report version of the AQS which is not considered as valid and reliable as the observer coded version (Solomon & George, 2016). The Preschool Assessments of Attachment continue to be debatable on their validity and reliability and there is still no gold-standard for preschool attachment measures (Spieker & Crittenden, 2009).

As attachment variables, patterns of attachment (ABCD or normative ABC coding) were assessed and reported in 12 studies (60%) and secure vs insecure categories were also used (20%). Six studies used continuous attachment security scores and two studies reported the interactive attachment behaviour scales as attachment variables, however only one of these studies specifically focused on resistant attachment behaviour (Simard, Bernier, Bélanger, & Carrier, 2013).

Four studies used ‘dependency’ as one of their attachment variables. Dependency is a construct difficult to define and studies differ on how they operationalise it. Studies focusing on attachment and sleep used this term to define infants (a) who receive higher scores on

Dependency sub-scale of Attachment Q-Sort (AQS) (Waters & Deane, 1985) which is measured by items such as 'cries at separation' or 'becomes distressed when adult moves away'; (b) infants receiving B4 classification in the SSP who are characterised by displaying more proximity seeking and contact maintenance behaviours while having less active exploration and play at reunions when compared to other secure infants (Ainsworth et al., 1978). Dependency is a natural part of a mother-infant relationship and an infant can display rather dependent behaviours and have a secure attachment at the same time (i.e. infants with B4 pattern). In fact, this may also be considered as a temperamental bias (Belsky & Rovine, 1987). Therefore, dependency is worth keeping as a factor but rather than an attachment-related factor, it may be better to consider it as a temperamental bias (Ainsworth et al., 1978).

Contributing factors. Most studies failed to include the majority of the contributing factors explained above, except for five studies (Beijers, Jansen, Riksen-Walraven, & de Weerth, 2011; Mileva-Seitz et al., 2016; Morrell & Steele, 2003; Sagi et al., 1994; Weinraub et al., 2012). Infant temperament, and maternal depression were the most frequently measured factors (35% each), followed by maternal sensitivity (25%) and parental nighttime interactions or place of infant sleep (20% each). Only one study included maternal cognitions about infant sleep (Morrell & Steele, 2003) and one study included infants' separation distress as measured by cry duration during the SSP separation episode (Weinraub et al., 2012).

Methodological quality. According to the standard quality assessment (Kmet et al., 2004) seven studies (35%) were identified as showing strong features of quality scoring >80%. Studies measuring attachment and sleep concurrently mostly showed adequate quality with only one study showing good quality (70-80%). Meanwhile, three studies showed limited quality (<50%) (McNamara et al., 2003; Scher & Asher, 2004; Seifer et al., 1996). The major issue observed with these studies were the lack of an objective measure of sleep or attachment, not controlling for possible confounding factors, and conclusions not being supported by the results which were provided with insufficient details. It was observed that, studies with the most definitive results on the relationship between attachment insecurity and less optimal sleep were coming from lower quality studies. Whereas, the strong quality studies were the ones which included most of the contributing factors into their analysis and it seemed that the more the covariates were included, the less strong the associations became. These findings are discussed further below.

Table 1. *Longitudinal studies on attachment and sleep, with sleep as the predictor variable*

Author(s) & participants	Design	Sleep measures (age)	Sleep Variables	Attachment measures (age)	Attachment variables (& distributions)	Contributing factors (age)	Main Findings *(& supporting theoretical model)*	Quality rating
(McNamara et al., 2003) Birth cohort*, 342 USA infants	Prospective longitudinal at 6 and 15 mos.	(Q) MR on Infant's sleep (6 & 15 mo.)	ISD based on OC NW NW-DUR	SSP (15 mo.)	Normative A (56%) C (44%)	None	C infants were more likely to have ISD at 6 & 15 mo. than A infants. At 15 mo. mean NW-DUR of C infants was longer than A infants. *(Model 3)*	Limited 10/22 45%
(Beijers et al., 2011) Birth cohort, 193 Dutch infants	Prospective longitudinal at 1-6 mos. & at 12 mo.	(SD) MR (continuous btw 1-27 weeks & 2 weeks at 12 mo.)	NW	SSP (12 mo.)	A (4%), B (68.2%), C (11.9%) & D (13.6%)	Infant Negative Affectivity (3,6 & 12 mos.), Maternal Depression (3,6 & 12 mos.), Maternal Sensitivity and Cooperation (5 weeks), Average % of Co-sleeping per week, Average # of daily breastfeeding, infant gender, maternal education, # of siblings	Infants classified as A at 12 mo.: showed a sharp decrease of NW around 9 weeks and remained stable at 0.2 wakings per night until 27 weeks and were waking the least. At 12 mo., they rarely needed to be resettled. Infants classified as C at 12 mo.: woke the most towards the end of the 6 mo. When compared to other infants, they showed more night wakings during the first 6 mo. N.S. associations between attachment patterns and NW at 12 mos. *(Model 1)*	Strong 19/22 86%
(Zentall et al., 2012) Birth cohort, 46 USA infants	Prospective longitudinal at 7, 12 & 14 mos.	(Q) MR-Checklist (7, 12, &14 mo.)	NW	SSP (with mother at 12 mo. & with father at 14 mo.)	For mothers: A (4%) **, B (63%), B4 (30%), C (15%), D (17%) For fathers: A (4%) **, B (71%), C (2%) **, D (19%)	Parental age, education & work hours, ethnicity, family income, parents' living status, number of siblings	NW of B infants (with mothers) tended to decrease from 7 to 14 months. NW of C infants (to mothers) tended to remain stable from 7 to 14 mos. At 12 mo. C infants (with mothers) had more NW than B infants. B4 infants (with mothers) had less NW than C infants at 12 and 14 mo. *(Model 1& 2)*	Adequate 11/22 50%

(Weinraub et al., 2012) Birth cohort*, 1364 USA infants	Prospective longitudinal at 6, 15, 24 & 36 mos.	(Q) MR (6, 15, 24, & 36 mo.)	# of nights with NW per week	SSP (15 mos.)	Secure vs Insecure A, B, C, & D [a]	Separation anxiety at SSP separation episode 6 (15 mo.), Difficult Temperament (6 mo.), Maternal Sensitivity (6,15,24 & 36 mos.), Maternal Depression (6, 15, 24, & 36 mo.), Marital Conflict, Breastfeeding, Child Illness, Child gender, birth weight, birth order, ethnicity, second parent/partner in home, family size, partner's health, poverty, maternal education, child care	No differences between 'sleepers' (66%) and 'transient sleepers' (34%) in attachment variables. 'Transient sleepers' woke up regularly until 18 mo. and were more likely to be boys, breastfed, perceived as having difficult temperament and have a depressed mother at 6 mo., have a sensitive mother and their mothers were more likely to have a partner or husband with illness, and come from a larger family. *(Model 4)*	Strong 19/22 86%
(Schwichtenberg et al., 2013) Birth cohort, 171 preterm USA infants (GA<36 weeks)	Prospective longitudinal at corrected 4, 9 & 16 mos.	(SD) MR at least 4 consecutive days (4 & 9 mo.)	Daytime Total Sleep DUR, # of Day Naps, Nighttime Total Sleep DUR, NW >15 minutes	SSP (16mo.)	Secure (59%) vs Insecure (41 %:)	Maternal Sensitivity (4 & 9 months.), Index score of infant prematurity, Family sociodemographic risks index	Preterm infants with more number of day naps and longer duration of daytime sleep at 4 and 9 mo. were more likely to have B pattern at 16 mo. *(Model 1)*	Good 16/22 72%
(Pennestri et al., 2015) Birth cohort, 134 Canadian infants	Prospective longitudinal at	(Q) MR on sleep during previous week (6, 12, 24, 36 mo.)	NW Duration of time in bed (total nighttime sleep)	PSRP (36 mo.)	A (6.7%) ** B (52.2%) C (17.2%) D (23.9%)	Maternal Depression (36 mo.), birth weight percentile, SES	<u>Infants who were later classified as D:</u> Across different time points slept 30 min. less than C infants, had more NW than B infants and regardless of time points went to bed 30 min. later than B & C infants. At 6 mo. spent 80 min. less time in bed than infants with B & C patterns. At 12 mo. slept less than B & C infants. When SES is added as a covariate, at 12 mo. D infants had more NW than B & C infants. *(Model 1)*	Adequate 12/22 54%

(Mileva-Seitz et al., 2016) Birth cohort, 550 Dutch infants	Prospective longitudinal at 2 & 14 mos.	(Q) MR on frequency of bed-sharing (2 mo.)	Frequency of child sleeping in the same bed with parent(s) (2 mo.) Solitary Sleeping vs Bed-sharing Solitary-Sleeping vs Some-bed-sharing vs Frequent-bed-sharing	SSP (14 mo.)	Normative A (20% vs 19% vs 12%), B (52% vs 63% vs 62.7%), C (27% vs 18% vs 25%) Secure vs insecure Organised vs disorganised (24% vs 20% vs 25%) Attachment Security Score (cont.) via modified Richters' Formula Attachment Disorganisation Score (cont.)	Parental nighttime caregiving (Questionnaire, distal vs proximal, 2 mo.), Maternal Depression (2 mo.), Infant temperament (perceived alertness/responsiveness and unsettled irregular behaviour at 2 mo.), Breastfeeding duration at 2 mo., Maternal age, education, infant parity, number of household members	<u>Infants who were only-solitary-sleeping at 2 mo.:</u> had lower attachment security score at 14 mo. than all bed-sharers. They showed the highest risk for developing insecure attachment. They had greater odds of being insecurely attached than all bed-sharers and greater odds of developing C pattern than all bed-sharers. <u>Infants in some-bed-sharing at 2 mo. group:</u> Greater secure attachment scores at 14 mo. than solitary sleeping and frequent bed-sharing groups. They were less likely to develop insecure attachment and within insecure attachment groups, they were less likely to develop C pattern. *(Model 1)*	Strong 19/22 86%
(Newland, Parade, Dickstein, & Seifer, 2016) Birth cohort, 173 USA infants and mothers	Prospective longitudinal at prenatal, 8, 15 & 30 mo.	(SD) MR & (A) Obj, for at least 5 consecutive days (8 mo.)	NW-DUR (From SD: average amount of minutes awake during the night across days; High vs Low) Night-to-night variability in infant SE (from Actigraphy. High vs Low)	AQS by observer (30 mo.)	Attachment Security Score (cont.)	Maternal sleep (prenatal: High, medium & low), Maternal Depression (prenatal & 15 mo.), SES	When controlled for SES and maternal prenatal depression, mothers with good quality of prenatal sleep having an infant with long NW-DUR at 8 mo. were more likely to have higher scores on depression at 15 mo. and their infants were more likely to have lower scores on attachment security at 30 mo. *(Model 4)*	Strong 18/22 82%

Note. [a] Distributions were not reported. [*]National Institute of Child Health and Human Development Study of Early Child Care Sample, [**]not analysed due to small sample size, # number, "A" = Avoidant-insecure attachment, (A) = Actigraphy, AQS = Attachment Q-Sort, "B" = Secure attachment, btw = between, "C" = Ambivalent/resistant-insecure attachment, "D" = Disorganised attachment, DUR = duration, GA = Gestational age, ISD = Infant sleep disturbance, MR = Maternal report, N.S. = Non-significant, NW = Night waking, Obj. = objective, OC = Objective criteria such as Richman's (1981) or Zuckerman's (1987), PSRP = Preschool Separation Reunion Procedure, (Q) = Questionnaire or specific questions on sleep (SD) = Sleep Diary, SE = Sleep efficiency, SES = Socioeconomic status, SSP = Strange Situation Procedure.

Studies with sleep as the predictor variable. Table 1 shows eight prospective longitudinal studies measuring sleep first and attachment later. All studies employed birth-cohort samples and all except one study focused on general sleep patterns of infants. The range of time points to collect sleep data was from the first week of life to 36 months and the age range of attachment measures was 12 to 36 months. Supporting and opposing evidence for the relationship between each attachment pattern and sleep patterns or ISD are summarised below.

Secure attachment and sleep patterns. While Newland et al. (2016) found no direct effect of infant sleep at eight months on later attachment security, two studies found a positive relationship between secure attachment and healthy sleep patterns. Schwichtenberg et al. (2013) found that, after controlling for maternal sensitivity, preterm infants with more and longer daytime naps at 4 and 9 months were more likely to be classified as having secure attachment when they were 16 months old. Zentall et al. (2012) reported that number of night wakings of infants who were later classified as secure tended to decrease from 7 to 14 months.

Insecure (overall) attachment and sleep patterns. Three studies reported results for a broad group of infants with insecure attachment or lower security continuous, rather than categorical scores. Newland et al. (2016) pointed out a relationship between longer night wakings at eight months and attachment insecurity at 30 months when there was a mismatch between infants' sleep and mothers' prenatal sleep and only when mothers were depressed when the infant was 15 months old. Weinraub et al. (2012), on the other hand, found no effect of any attachment variables on the development of two different trajectories of night wakings from infancy through toddlerhood. This study used the full sample of NICHD Early Child Care with all possible contributing factors taken into account. However the sample was divided into groups of 'sleepers' (%66) and 'transient sleepers' (%34) based on maternal reports on number of nights with waking per week rather than the total number of awakenings per week. Schwichtenberg et al. (2013) also did not find a relationship between number of night wakings at four and nine months and later attachment classifications of preterm infants. They related this result to the fact that mothers were asked to report night wakings only if they were longer than 15 minutes which may have prevented mothers from reporting more frequent but short duration night wakings.

Avoidant pattern of attachment and sleep patterns. In a longitudinal study done with Dutch infants (Beijers et al., 2011), comparing sleep diary parameters of infants from birth to 6 months, night wakings of infants who were later classified as having avoidant patterns tended to decrease sharply around nine weeks of life and stayed stable from then on with a mean of 0.2 per night until six months. In fact, at 12 months they rarely needed to be settled back to sleep.

Ambivalent/resistant pattern of attachment and sleep patterns. Although not directly related to infant sleep patterns, the study done by Mileva-Seitz et al. (2016) indicated a relationship between the place of sleep at night and having an ambivalent/resistant attachment pattern. They found that, after controlling for infant, parent, and contextual factors, infants who slept in their cot all night without any bed or room sharing with their parents at two months were more likely to have an ambivalent/resistant attachment pattern at 14 months.

In terms of number of night wakings, there were two longitudinal studies (Beijers et al., 2011; Zentall et al., 2012) indicating that infants who were later classified as having ambivalent/resistant attachment patterns tended to have more night wakings throughout the first year of life when compared to infants with secure, avoidant, and disorganised attachment patterns. In the study done by McNamara et al. (2003), comparing infants with avoidant and ambivalent/resistant patterns, 15 months old infants with ambivalent/resistant attachment were reported by their mothers as having longer durations of night wakings than infants with avoidant patterns.

Dependency and sleep patterns. Zentall et al. (2012), using SSP, did not find B4 infants as having more night wakings than other secure and insecure infants.

*Disorganised pattern of attachment and sleep patterns***.** Pennestri et al. (2015) was the only study demonstrating an association between disorganised attachment pattern in preschool years and sleep in infancy. They reported that preschool children who were identified as having disorganised attachment at age three had a different trajectory of sleep when compared to infants with secure and ambivalent/resistant attachment patterns. They tended to sleep less, have more night wakings, go to bed later, and spend less time in bed across different time points through their infancy.

Secure attachment and ISD. Although McNamara et al. (2003) did measure ISD, they did not include the secure attachment group in their analysis.

Ambivalent/resistant pattern of attachment and ISD. McNamara et al. (2003) concluded that infants with ambivalent/resistant attachment patterns at 15 months were more likely to be perceived as having sleep problems when they were both six and 15 months old when compared to infants with avoidant attachment patterns.

Summary of findings from strong quality studies. Four studies (Beijers et al., 2011; Mileva-Seitz et al., 2016; Newland et al., 2016; Weinraub et al., 2012) had a high quality rating which were all done with normative populations without addressing whether mothers considered their infants' sleep as a problem and the findings from these studies, exploring whether sleep has an effect on later attachment quality, were mixed. While Weinraub et al. (2012) found no effect, some support was found in the other studies although the variables and relationships explored were not straightforward. Beijers et al. (2011) found that there were developmental differences in the night waking patterns of infants who were later classified as avoidant and ambivalent. Mileva-Seitz et al. (2016) indicated that the place of sleep (i.e. solitary sleeping at two months vs some or always bed-sharing) had an impact on later attachment quality. Further, Newland et al. (2016) found no direct effect of early infant sleep on later attachment security, however, found an interaction effect of the mismatch between maternal prenatal sleep and early infant sleep on later maternal depression which then led to insecure attachment at toddlerhood.

Table 2. *Longitudinal studies on attachment and sleep, with attachment as the predictor variable*

Author(s)/ participants	Design	Sleep measures (age)	Sleep variables	Attachment measures (age)	Attachment variables (& distributions)	Contributing factors (age)	Main Findings *(& supporting theoretical model)*	Quality rating
(Seifer et al., 1996) 92 US infants of mothers with mental health problems	Prospective longitudinal, at 12 and 33 mos.	(Q) MR-via SHQ (33 mo.)	NW	SSP (12 mo.)	Secure vs insecure [a]	Child internalising & externalising problems (33 & 48 mos.), Maternal Psychopathology (12 mo.), Family Functioning (12 mo.), Child illness	There was a negative correlation between attachment security at 12 mo. and NW at 33 mo. (*Model 2)*	Limited 10/22 45%
(Morrell & Steele, 2003) 100 UK infants	Case-control at 15 mo. (range = 14-16 mos. Case *M* = 15.3, *SD* = .80 vs Control *M* = 15.0, *SD* = .56) & follow up at 27mo.	(Q) MR via ISQ (15 mo. & 27 mo.) (SD) MR for 2 weeks (15 mo.)	ISD based on both MR and OC (Richman's, 1981) NW	SSP (15 mo.)	A (15% vs 11%) B (77% vs 65%) C (0% vs 7% D (8% vs 17%) Normative C (1.7% vs 12.5%)	Difficult Temperament (15 mo.), Maternal Cognitions about Infant Sleep (15 mo.), Parental Behaviours at Night (15 mo.), Parental Early Experiences (15 mo.), Maternal Mood (15 mo.), Marital Conflict (15 mo.), Parental Social Support (15 mo.), Stressful Life Events (15 mo.)	At 15 mo.: ISD group (40%) had more normative C infants than non-ISD group (60%) (12.7% vs 1.7%). C infants had more NW than A & B infants. Having C pattern explained 4% of the variance in the logistic regression model as the 4th important factor, coming after mother's difficulty with setting limits, infant's difficult temperament and maternal mood. Infants having both ISD and fussy/difficult temperament at age 1 whose mothers have problematic cognitions on their infant's sleep were more likely to be settled to sleep by active physical comforting, therefore, were more likely to continue having sleep problems at age 2. At 27 mo.: C infants at 15 mo. were more likely to continue having ISD at 27 mo. compared to A & B infants. (*Models 2,3 & 4)*	Good 17/22 77%
(Troxel et al., 2013) Birth cohort*, 776 USA infants	Prospective longitudinal at 6, 24 & 36 months	(Q) MR-CBCL 2/3 Sleep Problems Subscale (24 and 36 mos.)	ISD based on MR	AQS (24 mo.)	Secure vs Insecure [a]	Negative Emotionality (6 mo.), Emotional and Behavioural Problems (24 mo. by parents and 54 mo. by teachers), Maternal Depression (24 mo.), Maternal education, single-parent status, sex, ethnicity	Infants who were high in negative emotionality at 6 mo. and had insecure attachment at age 2 were more likely to have higher scores on sleep problems at age 3 and were more likely to have emotional and behavioural problems at age 4.5. *(Model 2)*	Strong 18/22 81%

(Simard et al., 2013) 55 Canadian infants	Prospective longitudinal at 18 and 24 months	(SD) MR & (A) Obj. for 72 hours (24 mo.)	MR: Sleep-DUR, NW-DUR Obj.: Sleep-DUR, NW-DUR, NW (SD)-(A) difference scores	SSP (18 mo.)	A (16%)** B (56%)** C (0.5%)** D (4%)** Interactive attachment behaviour scales	Gender, parental education, family yearly income, birth order, number of rooms in the house, medical problems during pregnancy, alcohol/substance consumption during pregnancy, birth weight, child's health	Higher scores on resistance behaviour during SSP predicted longer maternal report NW-DUR and less (SD)-(A) difference scores on sleep duration and NW-DUR. (*Model 2)*	Strong 18/22 81%
(Ding et al., 2014) 118 Chinese infants	Prospective longitudinal at 14 and 36 months	(Q) MR-CBCL 2/3-Sleep Problems Subscale (36 mo.)	ISD based on MR	SSP (14 mo.) AQS (36 mo.)	A (8%) B (66%) C (23%) D (3%) Secure vs insecure	Child cognitive development (36 mo.)	When compared to B infants, C infants at 14 mo. had higher scores on Sleep Problems subscale of CBCL at 36 mo. (*Model 2)*	Adequate 15/22 65%
(Bélanger, Bernier, Simard, Bordeleau, & Carrier, 2015) 62 Canadian infants	Prospective longitudinal at 15 and 24 mos.	(SD) MR & (A) Obj. for 72 hours (24 mo.)	Obj. Sleep-DUR at night, SE, Sleep-DUR over 24 hr period	AQS (15 mo.)	Security score (cont.) Dependency score (cont.)	Maternal Education, Duration of Breastfeeding during infancy	After controlling for confounding variables and child dependency, higher scores on attachment security at 15 mo. explained 10% of the variance in Sleep-DUR at night and 11% of the variance in SE at age 2 (higher security-more sleep minutes and greater SE). Higher dependency scores correlated with less Sleep-DUR at night. (*Model 2)*	Strong 18/22 81%

Note. [a] Distributions were not reported, * National Institute of Child Health and Human Development Study of Early Child Care Sample, ** not analysed due to small sample size, # = number, “A” = Avoidant-insecure attachment, (A) = Actigraphy, AQS = Attachment Q-Sort, “B” = Secure attachment, btw = between, “C” = Ambivalent/resistant-insecure attachment, CBCL 2/3 = Child Behavior Checklist for 2-3 years, “D” = Disorganised attachment, DUR = duration, GA = Gestational age, ISQ = Infant Sleep Questionnaire, ISD = Infant sleep disturbance, *M* = Mean, MR = Maternal report, NW = Night waking, Obj. = objective, OC = Objective criteria such as Richman’s (1981) or Zuckerman’s (1987), (Q) = Questionnaire or specific questions on sleep, *SD* = Standard deviation, (SD) = Sleep Diary, SE = Sleep efficiency, SES = Socioeconomic status, SHQ = Sleep Habits Questionnaire SSP = Strange Situation Procedure.

Studies with attachment as the predictor variable. Table 2 shows six prospective longitudinal studies and one which assessed attachment first and sleep later. Three studies looked at ISD as one of the sleep variables or used sleep criteria as a group category. One study used a case-control design at 15 months with a follow up at 27 months. In other studies the age range of attachment measures was 12 to 24 months and the sleep data were collected at up to 36 months. Therefore, these participants' average age was older than the ones described above.

Secure attachment and sleep patterns. Bélanger et al. (2015) demonstrated that when maternal education, duration of breastfeeding and infants' dependency score on AQS were controlled, having higher security scores at 15 months predicted longer and better quality of sleep at night time when toddlers were 2 years old.

Insecure (overall) attachment and sleep patterns. Seifer et al. (1996) reported a negative correlation between attachment security at 12 months and number of night wakings at 33 months, however, the quality of this study was limited as confounding factors were not controlled and higher level analysis were not conducted.

Ambivalent/resistant pattern of attachment and sleep patterns. Morrell and Steele (2003) also suggested that 14-16 months old infants with ambivalent/resistant attachment pattern had more reported night wakings than infants with secure and avoidant attachment patterns. Simard et al. (2013) suggested that infants with higher resistance behaviour scores on SSP, which is a characteristic of the B4 or ambivalent/resistant attachment categories, had significantly longer duration of night wakings as reported by their mothers.

Dependency and sleep patterns. Bélanger et al. (2015) reported that higher dependency scores at 15 months were correlated with less sleep duration at night as objectively measured.

Secure attachment and ISD. The attachment patterns of the ISD group in Morrell and Steele (2003) study included 65% secure attachment compared to 77% in the control group, however, the statistical difference was not reported.

Insecure (overall) attachment and ISD. Troxel et al. (2013) found a relationship between insecure attachment at age two and higher scores on sleep problems at age three but only for toddlers who had high negative emotionality during free play at six months. Therefore, this study's findings seem to suggest that preschool children who showed more negative emotionality during free play when they were six months old and had insecure attachment when they were toddlers were more likely to be rated as having sleep problems by their mothers.

Ambivalent/resistant pattern of attachment and ISD. Ding et al. (2014) provided the first evidence from China, indicating that infants with ambivalent/resistant attachment at 14 months were more likely to be rated as having sleep problems at age three. However they did not measure any of the contributing factors. The study conducted by Morrell and Steele (2003) gave the most detailed information on the possible mechanisms of development of sleep problems as suggested in the transactional model (Sadeh & Anders, 1993) and specifically explored the relationship between sleep problems and ambivalent/resistant attachment. Results indicated that infants in the sleep problem group had significantly more ambivalent/resistant attachment patterns as categorised with the ABC coding than infants in the control group. In their logistic regression model, having ambivalent/resistant attachment explained 4% of the variance and appeared to be the 4th most important factor in association with having sleep problems. Moreover, having an ambivalent/resistant attachment pattern and a sleep problem at age one was directly associated with persistent sleep problems at age two. In other words, infants with ambivalent/resistant attachment patterns and sleep problems when they were one year old were more likely to continue having sleep problems at age two.

Summary of findings from strong quality studies. Three studies on Table 2 had a strong quality rating and the findings from these studies, to explore whether attachment has an effect on later sleep patterns (or having ISD), were partially supportive. Troxel et al. (2013) made a unique contribution to our understanding of the possible mechanisms as this study acknowledges the possible relationships between persistence of sleep problems and insecure attachment, with a moderation effect of negative emotionality in early infancy, and their possible effects on later functioning of preschool children.

On the other hand Simard et al. (2013) did not find any associations between their attachment and sleep variables, however, if toddlers showed more resistant behaviours during SSP, then their mothers were more accurate with their reports on their children's duration of night wakings and total night sleep duration which might suggest that the overt resistant attachment behaviours may have an influence on how mothers perceive their infants' sleep. Bélanger et al. (2015) also found an association between higher dependency scores (which can be considered equal to resistant behaviours in SSP) and shorter objectively-measured total night sleep duration. In addition, higher security scores predicted better sleep quality and longer total night sleep duration.

These findings nevertheless should be interpreted with caution because Simard et al and Belanger et al had small sample sizes and the sample in the Troxel et al. (2013) study did not have scores above the clinical cut-off on the sleep problem sub-scale of Child Behavior Checklist (CBCL 2/3).

Table 3. *Cross-sectional and longitudinal studies on attachment and sleep, measuring sleep and attachment concurrently*

Author(s)/ participants	Design	Sleep measures (age)	Sleep variables	Attachment measures (age)	Attachment variables (& distributions)	Contributing factors (age)	Main Findings *(& supporting theoretical model)*	Quality rating
(Sagi et al., 1994) 48 Israeli infants	Cross-sectional, Quasi-experimental case-control (age range = 14-22 mos., *M* = 18.29, *SD* = 2.25)	Place of sleep at nighttime	Communal sleep arrangement in Kibbutz [b] (*n* = 25) vs Home-based sleep arrangement (*n* = 23)	SSP	Normative B (48% vs 80%) C (52% vs 20%) With D B (26% vs 60%) C (30% vs 8%) D (44% vs 32%)	Infant Difficult Temperament, infants' separation from parents frequency and duration, Quality of mother-infant interactions at Kibbutz, Mothers' biographical characteristics (age, number of children, education, professional training, and kibbutz experiences as a child), Maternal trauma, , Maternal Separation Anxiety, Nursing Child Assessment teaching Scales, Maternal satisfaction with Kibbutz	Both groups scored similar on all variables measured in the study except the distribution of attachment patterns. Infants sleeping in communal setting had significantly less B pattern and more C pattern than infants sleeping at home setting (when controlled for the frequency of infants' separation from their parents). *(Model 1)*	Adequate 13/22 59%
(Scher, 2001a) 94 Israeli infants	Prospective longitudinal (with case-control) at 9 & 12 mo.	(Q) MR via SHQ (12 mo.) & (A) obj. for a sub-group of 37 infants for 2 consecutive nights (12 mo.)	ISD (wakers *n* = 52 vs non-wakers *n* = 42) based on MR Bedtime settling difficulty Sleep Index based on OC Waking Index based on OC Obj.: SE, sleep onset time, Sleep-DUR, longest uninterrupted sleep interval, NW> 5 min.	SSP (12 mo.)	Normative A (n= 1)[**] B (55% vs 45%) C (60% vs 40%) B4 (21%) Interactive Attachment Behaviour Scales	Infant Difficult/Fussy Temperament (9 mo.)	Bedtime settling difficulties were more reported by mothers of B and B4 infants when compared to insecure infants. Wakers group scored higher on contact-maintenance scale than non-wakers. Proximity seeking scale was positively correlated with sleep duration and avoidance scale was negatively correlated with the number of awakenings as measured by actigraphy. Based on actigraphy, there was a significant interaction between attachment classification (B vs C) and level of fussiness: sleep efficiency and the number of awakenings were dependent upon the interaction between attachment and temperament. (*Model 1)*	Adequate 13/22 59%

(Scher & Asher, 2004) 57 Israeli infants	Prospective longitudinal at 8 & 12 mos.	(Q) MR via SHQ & ISQ (SD) MR (12 mo.) & (A) obj. for 3 consecutive nights (from 52 infants, 12 mo.)	ISD based on MR & OC Awakening Index (MR) SE NW (longer than 5 mins)	AQS (MR version, 12 mo.)	Security score (cont.) Dependency score (cont.)	Infant Difficult/Fussy Temperament (8 mo.), Parental bedtime routines and strategies (active physical comforting vs encourage autonomy-12 mo.)	The average NW-DUR was negatively correlated with the attachment security. The dependency moderately associated with ISD, positively correlated with fussiness and lateness of bedtime. Infants who met the Richman's criteria for ISD were more likely to be fussy and dependent. (*Model 1)*	Limited 10/22 45%
(Higley & Dozier, 2009) 44 USA infants	Cross-sectional (age range = 11.4-14.4 mos. *M* =12.78, *SD* = .77)	(SD) MR & (VSG) obj. for 3 consecutive nights	Clear Signallers (*n* = 23) vs Non-clear signallers (*n* = 21)	SSP	A (5%) B (61%) C (7%) D (27%)	Maternal nighttime behaviours, Mother-infant nighttime interaction pattern, Infant Temperament, Demographics	No association between clear (63% secure) vs not-clear (37% secure) signalling and attachment patterns. Mothers of clear-signaller B infants were more likely to use 'pick up/soothe' pattern of nighttime interaction when compared to mothers of clear-signaller insecure infants. *(Model 1)*	Adequate 15/22 68%
(Vaughn et al., 2011) 34 USA children	Cross-sectional (age range = 3-5 yrs.)	(SD) MR & (A) obj. for 7 consecutive days	Obj: SE, Sleep-DUR, Total Sleep Minutes, Sleep Episodes, Longest Wake Episode, Sleep Activity Mean, Overall Activity Index, Wake Minutes After Sleep Onset, Sleep Latency	ASCT	Composite Security Score (from Security/Coherence scales)	Temperament (Effortful Control), Social Competence, Emotion Knowledge, Classroom Adjustment, Child verbal intelligence	Preschool children with low scores on attachment composite score were more likely to have lower scores on SE and showed more night time activity and longer NW-DUR compared to children with higher scores on attachment composite score. (*Model 2)*	Adequate 11/22 50%

(Bernier, Belanger, Tarabulsy, Simard, & Carrier, 2014) 63 Canadian infants	Prospective longitudinal at 8 and 24 months	(SD) MR & (A) obj. for 72 hours (24 mo.)	Sleep-DUR at night (obj.) Proportion of nighttime sleep to total sleep per 24 hr (obj.)	AQS by observer (24 mo.)	Security score (cont.)	Maternal sensitivity (8 m.), Executive functioning (24 mo.), Theory of mind (24 mo.), SES	Maternal sensitivity interacted with nighttime sleep duration in predicting infant attachment security. Higher maternal sensitivity at 8 mo. was related to greater attachment security score at age 2 for infants who slept longer at night at age 2 but was unrelated to attachment security for those with shorter nighttime sleep duration. *(Model 4)*	Good 17/22 77%

Note. ** Not analysed due to small sample size, # = number, [b] = Kibbutz is a collective settlement in which children of the collective's members are looked after in a communal setting by carers selected from the community. See the original article for more information. "A" = Avoidant-insecure attachment, (A) = Actigraphy, AQS = Attachment Q-Sort, ASCT = Attachment Story Completion Task, "B" = Secure attachment, btw = between, "C" = Ambivalent/resistant-insecure attachment, CBCL 2/3 = Child Behavior Checklist for 2-3 years, "D" = Disorganised attachment, DUR = duration, GA = Gestational age, ISQ = Infant Sleep Questionnaire, ISD = Infant sleep disturbance, *M* = Mean, MR = Maternal report, N.S. = Non-significant, NW = Night waking, Obj. = objective, OC = Objective criteria such as Richman's (1981) or Zuckerman's (1987), (Q) = Questionnaire or specific questions on sleep, *SD* = Standard deviation, (SD) = Sleep Diary, SE = Sleep efficiency, SES = Socioeconomic status, SHQ = Sleep Habits Questionnaire, SSP = Strange Situation Procedure.

Studies measuring sleep and attachment concurrently. Table 3 shows cross-sectional and prospective longitudinal studies which assessed sleep and attachment at the same age. Two studies had ISD as a grouping variable. Among six studies, there was no study with strong quality and only one study received a good quality rating (Bernier et al., 2014) and the findings are described below.

Secure attachment and sleep patterns. Bernier et al. (2014) made a unique contribution by demonstrating the moderator effect of infant sleep between maternal sensitivity and attachment security as high maternal sensitivity at eight months was predictive of higher attachment security scores at 24 months only for infants who had good quality of sleep at 24 months, which means, good quality of sleep in toddlerhood was found to be a moderator between earlier maternal sensitivity and toddler attachment security.

Higley and Dozier (2009) found that when objectively measured, parents of 1-year-old secure infants, who clearly signalled their awakenings, tended to pick-up and soothe their infants consistently more than other parents with clear-signalling infants. However, parents' perception of their infant sleep as a problem was not asked.

Insecure (overall) attachment and sleep patterns. Vaughn et al. (2011), using an objective measure of sleep, found that preschool children with lower security/coherence scores on Attachment Story Completion Task (Solomon & George, 2016) had less sleep efficiency and longer night wakings than children with higher scores.

Avoidant pattern of attachment and sleep patterns. The study conducted by Scher (2001a) with 12 months old Israeli infants indicated that infants' avoidance behaviour scores on SSP were negatively correlated with number of night wakings, which means the higher the avoidance scores were, which is the hallmark of avoidant attachment pattern, the fewer were the awakenings at night.

Ambivalent/resistant pattern of attachment and sleep patterns. Although not directly related to infant sleep patterns, Sagi et al. (1994) reported that after controlling for mother, infant, and environmental factors, 1-year-old infants sleeping in a communal setting, which means receiving inconsistent caregiving from non-primary caregivers at nighttime, had significantly more ambivalent/resistant attachment patterns than infants sleeping at home with their parents. However, mothers' perception of their infants' sleep as a problem and infants' sleep arrangement at home (i.e. co-sleep or own bed) with their parents, and the quality of sleep were not measured in order to explore whether it is the sleep arrangement itself or the conditions surrounding this which are associated with attachment insecurity.

Secure attachment and ISD. Scher (2001a) reported that mothers of infants with secure attachment, especially B4 pattern, reported more bedtime settling difficulties than mothers of infants with insecure patterns. However, the quality of this study was not strong as the contributing factors were not controlled for and the results were not reported in sufficient detail. For instance, 'night wakers' group, based on maternal report, had more infants with fussy-difficult temperament however, infants with fussy-difficult temperament were also found to have higher scores on sleep efficiency as measured by actigraphy. This contradictory result was suggested to be a type-2 error.

Insecure (overall) attachment and ISD. Scher and Asher (2004) did not find any relationship between attachment insecurity and ISD, however, the quality of this study was also limited and they used the maternal report of AQS which is not considered as valid (Solomon & George, 2016).

Dependency and ISD. Along with attachment patterns, some studies focused specifically on dependency with an assumption that infants with a high level of dependency on their mothers may be more likely to have more difficulty with initiating and/or maintaining sleep (Scher, 2001a; Scher & Asher, 2004). Results from these studies supported this notion however, both had limited quality of standard.

Summary and conclusion. Twenty studies were identified and evaluated for methodological quality and evidence they provided for or against the relationship between sleep and attachment in the first five years of life. It was found that most studies were conducted with a sample of infants or toddlers with normative sleep patterns and those six studies with ISD as a grouping variable did not show a strong methodological quality except for one. In general, studies had issues with their sleep assessment techniques and had a wide variety of variables. Only nine studies used some combination of maternal report and an objective sleep measure and only two studies out of six used both maternal report and objective criteria for ISD (Morrell & Steele, 2003; Scher & Asher, 2004). Moreover, most studies failed to include the majority of the contributing factors, except for five studies. Nevertheless, seven studies (35%) were identified as showing strong features of quality, scoring >80%.

When findings from all studies are evaluated, it seems that the majority of supporting evidence is present for the relationship between the ambivalent-resistant attachment pattern and both having ISD and longer durations of frequent night wakings followed by the relationship between good quality of sleep and having secure attachment and infants with avoidant attachment pattern not displaying ISD. Strong quality studies, on the other hand, seem to suggest that attachment and sleep are both products of other contributing factors, especially parenting and infant temperament. However there is also no conclusive pattern observed other than the fact that the relationship becomes more apparent after attachment patterns are formed and sleep is measured in later toddlerhood.

Simard et al. (2017) conducted their meta-analysis with most of these studies evaluated above. They did not find a direct relationship between sleep and attachment and they agreed that the measures used in these studies were too subjective and there was a lack of consensus on the sleep variables which makes it harder to generalise the results. Their findings nevertheless suggested that there was a small to moderate association between secure attachment and higher sleep efficiency when measured objectively for toddlers and preschool children which goes in line with the indications of strong quality studies.

Simard et al (2017) also reported a significant relationship between sleep problems and resistant behaviours, but not ambivalent/resistant attachment pattern, only when sleep was measured with retrospective maternal reports. They argued that parents of infants with higher resistant behaviours may be more aware of their infants' awakenings and therefore be more accurate with their records and tend to report this as a problem more. Considering the common factor associated with ISD and the development of ambivalent/resistant attachment pattern, which is the unsynchronised, overstimulating pattern of interaction between the caregiver and an intrinsically reactive infant, this interpretation seems plausible.

The shortcomings of the strong quality studies are, although suggested theoretical models focus on the sleep problems and attachment insecurity, the variety of sleep variables used in these studies makes it harder to generalise their result and the majority of these did not measure ISD specifically which leaves the question whether the link between insecure attachment and ISD would be evident if strong quality studies considered this variable as well. Because persistent sleep problems and insecure attachment are aspects of two constructs with negative effects on later functioning, the focus of studies in this area should be more on the population with infant sleep perceived as a problem.

Theoretical implications. Since most of the studies described above had a sample of infants with normative sleep patterns and only six studies specifically focused on parents' perception of their infants' sleep as a problem, there needs to be a broad, inductive perspective in examining the 'why' aspect of the possible relationship and to cover all kinds of possible interactions between these two constructs. The literature so far, however, has emphasised the association between ISD and insecure attachment in all theoretical suggestions, except one.

The idea of a possible relationship between ISD and attachment was first introduced by Sadeh and Anders (1993) in their transactional model of ISD development. This was based on their clinical observations and they supported their argument by citing an article by M. S. Moore (1989) which was also based on a hypothetical argument of possible effects of anxious attachment patterns or disruptions in attachment relationships on children's sleep disturbance. Although these two articles do not include any empirical data, they have been widely cited in the literature as an evidence of an established relationship between insecure, especially ambivalent/resistant attachment pattern and ISD (Eckerberg, 2004; Morrell & Steele, 2003; Pennestri et al., 2015; Scher, 2001a). Keller (2011) summarised the suggested ideas and empirical data in the literature and suggested four conceptual frameworks to discuss possible mechanisms. Simard et al. (2017) further elaborated on these possible relationships based on the results of their meta-analysis of studies measuring both sleep and attachment patterns. However, they have not provided a new model to explain their findings.

In this section, previously suggested explanations for why ISD and attachment insecurity might be related are described, and supporting and opposing evidence for each model are provided. In addition, the background information provided in the above section, overlooked suggestions found in the literature, combined with findings from recent studies has informed the author to extend some of the suggestions in these models to cover all possibilities. These suggested extensions are described under each model and, from this section onwards, models will be referred as the extended models where necessary.

Model 1: ISD is a manifestation of an activated attachment system or nighttime sleep interactions in early life influence the emergence of attachment security. According to the first framework, which is also suggested by Sadeh and Anders (1993), ISD may be considered as a manifestation of the attachment relationship as the night time is a separation-reunion episode on a daily basis. Settling to sleep at night is a separation from the caregiver and waking at night into darkness and aloneness may therefore trigger attachment-related behaviours such as proximity seeking by calling out and crying. Therefore, Keller (2011) concluded that, ISD could be a part of the attachment behaviours repertoire of the infant, which means, infants with secure attachment or ambivalent/resistant attachment should display more ISD. It was also suggested that, as toddlers get older, the attachment “matures” and therefore sleep disruptions also decrease.

Developmentally Keller’s interpretation does present challenges. For nighttime wakings to trigger active proximity seeking behaviours, the attachment should be fully formed with a primary caregiver, which can only be observed after six months, and attachment behaviours should be visible, which occurs around 12 months. Therefore, the assumption in Keller’s first model may only be plausible when infants have sleep problems around 12 months of age. In fact, the studies with supporting evidence for this framework have generally been conducted with 12 months or older infants (Morrell & Steele, 2003; Scher, 2001a; Simard et al., 2013; Zentall et al., 2012). In addition, the escalation of night wakings around 9 to 12 months (Scher, 2001b) may also be considered as providing support to this framework. Interestingly, in one study, 12 month old infants who were classified as having an ISD based on maternal report tended to score higher on proximity seeking and contact maintenance scales of interactive attachment behaviours, which are typically scored high in B3 and B4 sub-types of secure and C1 sub-type of ambivalent/resistant attachment, when compared to infants without a sleep disturbance (Scher, 2001a). However, studies on the developmental trajectory of sleep patterns indicate that some infants may actually show more difficulties with sleep-wake regulation beginning as early as 2 months (Henderson, 2001; Henderson et al., 2010) while the ones with early self-soothing skills, which roughly comprise 70% of the population (Teng et al., 2012), do not signal their awakenings. Whether self-soothing or not, the majority of these infants will later become attached to their caregivers in some way (Mesman et al., 2016). Therefore, this framework fails to account for infants experiencing sleep difficulties before six months. In addition, parents who practice co-sleeping also report a high number of signalled awakenings at night (Beijers et al., 2011; Volkovich, Ben-Zion, Karny, Meiri, & Tikotzky, 2015). This means, although these infants' have their parents by their side for the whole night, they still signal when they wake which contradicts the darkness-loneliness argument of this approach.

In summary, Keller's interpretation of this framework may explain some 12 month old infants' frequent signalled awakenings, however, it fails to explain infants having sleep difficulties since birth and infants co-sleeping with their parents. It also omits the majority of infants who do have an attachment relationship but do not signal their awakenings. A closer look at the previous literature, however, revealed that the original suggestion was broader and emphasising a developmental aspect of a possible relationship between sleep and attachment.

Anders (1994), in his article on the relationship between sleep and attachment, further explained their perspective and it can be summarised as follows. Each night, falling asleep creates a natural separation from the caregiver which may trigger distress in both infant and the parent and waking at night is an opportunity to seek and obtain comfort from the caregiver. Therefore, night-time interactions with parents throughout the early months of life may influence the emergence of "the developing attachment system", meaning, through the opportunities of 'rupture and repair' (Tronick, 1989) kind of interactions throughout the night, interactions before and in-between sleep may actually facilitate the development of the pattern of infant attachment. So the emergence of the attachment pattern at 12 months would be influenced from how the dyad interacted at nighttime through the first year of life.

The support for this interpretation of this model comes from studies measuring sleep as the predictor variable (Beijers et al., 2011; Mileva-Seitz et al., 2016; Pennestri et al., 2015; Schwichtenberg et al., 2013; Zentall et al., 2012) and cross-sectional studies (Higley & Dozier, 2009; Sagi et al., 1994). Findings of studies measuring the sleep location (Mileva-Seitz et al., 2016; Sagi et al., 1994), which indicated that infants sleeping solitary at age two months or out of home setting at 12 months were more likely to have ambivalent/resistant attachment pattern, may suggest that these dyads missed the opportunity to reconnect and synchronise with each other at nighttime and infants could not find the consistent reassurance and settle through comfort during the months of the formation of goal-corrected behaviour systems. Further evidence is found in other studies measuring constructs such as the positive association between mother-infant gaze synchrony and better quality of sleep ((De Graag, Cox, Hasselman, Jansen, & De Weerth, 2012) and early maternal emotional availability at nighttime predicting good quality of sleep (Teti et al., 2010). Yet, there are also infants with secure attachment and ISD which clearly suggests that there are additional factors in play in the development of ISD even after the attachment behaviours are fully organised in an optimal way.

Model 2: Insecure attachment leads to ISD. According to Keller's second framework, infants with insecure, especially ambivalent/resistant attachment, have heightened stress about keeping proximity to their caregivers, so much so that they cannot settle to sleep with the fear of losing their caregiver from sight. Consequently, they keep waking up at night in order to check upon their caregiver and keep proximity (M. S. Moore, 1989). Therefore, insecure attachment may cause sleep disturbance (M. S. Moore, 1989). For this assumption, again, attachment behaviours need to be observable towards a primary caregiver which happens around 12 months of age. In fact, studies with supporting evidence for this assumption were all conducted with toddlers and preschool children (Bélanger et al., 2015; Troxel et al., 2013) and further support comes from studies conducted with primary school children (Keller et al., 2008; Minor, 2008). Specifically, Morrell and Steele (2003)'s findings with toddlers who continued having ISD at 1-year follow up supported this interpretation as they were more likely to be the ones with ambivalent/resistant attachment pattern.

In addition to this framework, McNamara et al. (2003) introduced the REM Sleep Hypothesis and stated that as infants with ambivalent/resistant attachment were preoccupied with their caregiver, they would have a heightened drive system which would increase the amount of REM sleep state which is associated with activation of the limbic system and transitions from REM to other states would therefore keep them waking frequently at night. This suggestion has not yet been empirically supported with objective measures of sleep states of infants and toddlers with sleep problems.

Keller (2011) and others (Scher, 2001a; Scher, 2008; Weinraub et al., 2012) use Dahl (1996)'s article as a supporting evidence for this framework since Dahl suggests that sleep is part of a larger cycle of arousal regulation and in a bidirectional relationship with attentional and emotional difficulties from childhood to adulthood. However, in contradiction to this model, he also reported that, although adult sleep can be disrupted by depression, anxiety, and threats perceived in the environment and a difference can clearly be seen in their nocturnal EEG measures, clinically depressed young children's nocturnal EEG measures looked undisrupted, when similar complaints about sleep were present. He concluded that babies and young children in fact seem to be immune to the effects of stress on their architecture of sleep, which he explained as a protection from arousal influences on frontal cortical and higher cognitive processes, which clearly have not yet developed in infancy. Therefore, Dahl contends, young children may be biologically programmed to rely on adults' protection, showing a stress response in their sleep architecture only once higher cortical functioning has developed at about early adolescence. Therefore, this framework may only be plausible for older children with persistent sleep problems or children who develop sleep problems secondarily as they become older.

Another way to support this suggestion would be the opposite approach, that is, expecting that the earlier secure attachment predicting better quality of sleep in later years. Accordingly, findings of Bélanger et al. (2015) and meta-analysis done by Simard et al. (2017) supported this assumption when sleep was measured objectively.

Model 3: ISD leads to insecure attachment. The third framework suggests that sleep disruptions through the first year of life may lead to attachment insecurity (Keller, 2011). When infants' sleep patterns do not show any improvement through the first year of life, it may put pressure on the infant-mother relationship, with moderating effects of sleeplessness, frustration, tiredness, and less felt-competence on the parent's part (Bell & Belsky, 2008; Bernier, Bélanger, et al., 2013; Meijer & van den Wittenboer, 2007; Meltzer & Mindell, 2007). The supporting evidence for this assumption needs to come from studies measuring ISD, however, results were mixed. While Morrell and Steele (2003) and McNamara et al. (2003) provided partial support, findings from Scher (2001b); Scher and Asher (2004) did not and three of these studies' results also indicated that infants who were identified as having ISD tended to have as equal a proportion of secure attachment pattern as any normative population does (Mesman et al., 2016; Morrell & Steele, 2003; Scher, 2001a).

Model 4: Attachment security and infant sleep are dual products of parenting and other contributing factors. Keller (2011), as the fourth framework, originally suggested that both attachment insecurity and ISD are products of "poor" parenting and therefore may not be directly related but moderated or mediated by parenting variables. There are two major challenges with the construction of this model; one is about the factors included in the model and the other is about the attributions used to describe those factors.

As discussed above, both sleep and attachment development are not independent from other contextual factors. Therefore, this model needs to be extended to include all contributing factors common to both sleep and attachment development in infant, parent, and environmental levels, instead of focusing on parenting variables only. As a matter of fact, Anders (1994) was first to suggest that there are common variables to affect both infant sleep and attachment development. He outlined, though did not discuss further, sleep aids, transitional objects, feeding interactions, infant temperament, parental psychopathology and stress as possible mediating and moderating factors between sleep and attachment in infancy. These suggestions, except for infant temperament, parental stress and psychopathology were neither referred in the studies measuring attachment and sleep nor were reported to be related to both sleep and attachment development. Nevertheless, the common contributing factors, as introduced in the background section of this study, are: infant negative emotionality, parental wellbeing, parental attachment and separation anxiety from their infant, parents' cognitions about their infants, parent-infant nighttime and daytime interactions, social support, and marital conflict.

Support for this extended interpretation of the 4th model is provided by strong to good quality studies (Bernier et al., 2014; Newland et al., 2016; Weinraub et al., 2012) and the meta-analysis of studies measuring infant sleep and attachment variables (Simard et al., 2017) which did not find a direct relationship between sleep and attachment. Sadeh et al. (2010), in their further elaboration on the transactional model of ISD, also argued that sleep problems may be explained more precisely by a construct associated with child temperament and maternal cognitions rather than with security of attachment. Accordingly, Morrell and Steele (2003) found that having ISD at 12 months was explained with mother's difficulty with limit setting at nighttime, as measured by the Maternal Cognitions about Infant Sleep Questionnaire (MCISQ), infant's perceived difficult temperament as measured by the Infant

Characteristics Questionnaire (ICQ), and maternal depression respectively, followed by having the ambivalent/resistant attachment pattern.

Furthermore, their association may not only be related to ISD and attachment insecurity, therefore, taking a deficits approach, as Keller did by labelling parenting variables as poor, would foreshorten understanding of the processes between these constructs. For example, Weinraub et al. (2012) found that toddlers who continued waking regularly at night in fact tended to have mothers with higher scores on maternal sensitivity. Higley and Dozier (2009) reported that mothers of securely attached, clear-signaller infants tended to pick up and sooth their infants at every night waking. Moreover, parenting itself might conversely be affected by the sleep disturbance (Brand, Furlano, Sidler, Schulz, & Holsboer-Trachsler, 2014; Hiscock & Fisher, 2015). Bernier et al. (2014), for instance, not only considered contributing factors suggested above, but also explored moderating and mediating effects of sleep on the interaction between attachment security and maternal sensitivity and the moderator effect of sleep was found to be significant.

Summary and conclusion. There are currently four suggested frameworks to explain the possible relationship between ISD and attachment insecurity and these were further extended to cover all aspects of a possible relationship between sleep and attachment. The extended models are (1) ISD is a manifestation of an activated attachment system or nighttime sleep interactions in early life influence the emergence of attachment security; (2) insecure attachment leads to ISD; (3) ISD leads to insecure attachment; and (4) attachment security and infant sleep are dual products of parenting and other contributing factors. Going back to focusing on the strong quality studies summarised in the Tables 1, 2, and 3, it seems that their results support Model 1 (Beijers et al., 2011; Mileva-Seitz et al., 2016), Model 2 (Bélanger et al., 2015; Simard et al., 2013; Troxel et al., 2013), and Model 4 (Bernier et al., 2014; Newland et al., 2016; Weinraub et al., 2012). These findings could be interpreted as following: (a) early interactions at nighttime may have an influence on attachment patterns of infants, however, (b) these interactions are dependent upon mutual infant, parent, and contextual factors; and (c) after the first year of life, the attachment pattern may be determining the trajectory of toddler’s sleep, in a way that, secure infants may continue to have a good quality of sleep or if they had ISD, problems may resolve in time, or infants with insecure attachment may become prone to develop sleep problems or if they had ISD, problems may persist. These theoretical suggestions hypothetically do not consider the possibility of intervening with ISD. The next section looks at the current literature on the effects of BSIs on attachment relationships.

Effects of Behavioural Sleep Interventions on the Quality of Attachment Relationship

Despite the ongoing discussions around the effects of behavioural sleep interventions on parent-infant relationships, there have been only three studies to date measuring attachment or a related construct with infants or children who received a BSI (France, 1992; Gradisar et al., 2016; Price et al., 2012). These studies were excluded from the systematic review as attachment was not measured before exposure to the intervention except in one study, however, it was unclear whether the measure utilised for this study was measuring the same construct of security within attachment theory. Therefore, these studies and their findings are summarised in this separate section.

France (1992) compared three groups of infants between 6 to 24 months of age, namely, the ones who had ISD and improved after receiving a BSI; the ones who had ISD but did not receive a BSI (sleep-disturbed control); and the ones without a BSI (control) for the secondary outcome variables of infant security and temperament. Infant security was measured via sleep-item corrected scores on the Flint Security Scale (Flint & Toronto Univ. Guidance, 1974), which is a maternal report with higher scores indicating more security, and infant temperamental biases were also measured via maternal report at before, during, and after intervention. Results indicated that security scores of infants who received an intervention increased significantly from baseline to 6 weeks after the intervention began, while scores of infants in other groups remained the same. In addition, infants who received an intervention were perceived as more agreeable, likeable and less emotional or tense after the intervention. This study was the first to indicate an improvement in the perceived security of infants who received a BSI with comparison of scores before and after the intervention with two control groups. However the Flint Security Scale has not been validated against any other attachment measure, therefore it is unknown whether the security construct of this measure is similar to the construct of security in attachment theory.

Price et al. (2012) conducted a long-term outcome evaluation of a randomised controlled trial on the effects of behavioural sleep interventions and measured the prevalence of attachment disorders in children who received a behavioural sleep intervention when they were 8 to 10 months old. Results indicated that, at the age of six, they did not show any differences in their sleep patterns when compared to the control children and they were not diagnosed with any sub-type of attachment disorders.

Recently, Gradisar et al. (2016) conducted a randomised controlled trial on the effects of graduated extinction, bedtime fading and sleep education on sleep patterns of infants and toddlers (age range = 6-16 months) with a 1-year follow up. The study also included secondary outcome variables of maternal mood and stress, the level of infant morning and evening secretion of the stress hormone (cortisol) which were measured at three time points within the first 3 months of the study. In addition, attachment patterns via SSP and emotional and behavioural problems of infants and toddlers via CBCL were measured one year after the baseline. Results showed that sleep patterns improved for both treatment groups (graduated extinction and bedtime fading) but not for the control group. Mothers' stress decreased and mood improved, infants' evening cortisol levels decreased for infants who received graduated extinction. There were no differences between groups in the distribution of attachment patterns of infants and toddlers, and there were no differences between groups one year after the baseline on any emotional and behavioural problems. Although this study has been the most thorough examination of secondary outcomes of BSIs, it was not clear whether the 12-month follow up was conducted at the mark of 12 months of age for each child or a year after the baseline. This differentiation is crucial in order to interpret the SSP findings as toddlers' reactions in the SSP are different from those of 12 months old infants'.

Conclusion. As described above, all three studies on the effects of BSIs on attachment relationship, especially, Gradisar et al's RCT, did not find any adverse effect in infancy and later childhood. However, there are no studies up to date that measured both sleep and attachment variables before and after a sleep intervention.

Rationale for the Current Research

ISD is a problem affecting about 30% of infants and parents worldwide. Persistency of ISD is associated with adversity in later functioning of children, especially attentional, behavioural, and emotional regulation skills. ISD has a bidirectional influence on parental wellbeing. Consequently, there are behavioural sleep interventions which are evidence-based and effectively resolve sleep disturbances. Because these are based on extinction principles, some parents are reluctant to implement these interventions and some researchers are against suggesting these to parents based on the assumption that BSIs may disrupt the attachment relationship. In contrast, literature also suggests that, with contributions from mediating and moderating factors, secure attachment is linked to good quality of sleep and having insecure attachment is linked with persistence of ISD, although the directionality is still unknown.

These two contradicting aspects of the relationship between sleep and attachment create a dilemma for parents whose infants experience ISD: if one does not intervene, there may be possible long-term consequences; if one does intervene, parents are afraid they may disrupt their relationship with their infant. The research to date has not been sufficient to provide a resolution for this dilemma because (1) the majority of research on the relationship between sleep and attachment has not focused on the contributing factors affecting the development of both sleep and attachment; (2) their samples did not comprise infants with ISD based on both maternal and objective criteria; and (3) there was only one study to measure attachment patterns of infants who received BSI using SSP and that was measured only once, at the follow up phase.

Consequently, there are two main aims of this research project: (1) to explore the relationship between ISD and the attachment quality of 1 year old infants taking into consideration the infant, parent, and contextual factors associated with both sleep and attachment development in the literature; (2) to ascertain whether implementing a BSI has an effect on the quality of attachment or whether the quality of attachment has an effect on the outcomes of a BSI by measuring attachment before and after the intervention. Owing to the ongoing dilemma, there was a unique opportunity to have a group of families who had an infant with ISD but did not want to receive an intervention. Having a comparison group of parents and infants with ISD allowed (a) the observation of the natural change in sleep and attachment through time; and (b) comparison of the characteristics of parents of infants with ISD based on their help-seeking preferences.

It is expected that, if having ISD and attachment insecurity are related then (a) both groups would have more insecure attachment patterns than reported in universal distributions. (b) Changing sleep patterns should change attachment patterns or changes in the sleep patterns would be related to the quality of attachment. If BSIs are disruptive to the attachment relationship then attachment patterns of infants would change to worse after the intervention. However this was not expected based on the evidence from previous studies. The expectation was to replicate the results of Gradisar et al. (2016)'s study.

In order to conduct research to test these hypotheses, a randomised controlled trial would be ideal. However this was not plausible with the resources available therefore, the next best option, single case design with combination of pre-test post-test longitudinal design was chosen. The single case design provides refined and detailed answers for the aims of this study. In addition, this is the first study in the literature employing a single case design approach rather than group design with multiple objective point-per-phase measures as well as time-series data on sleep. This allowed the collection of more information on sleep, attachment and other contributing factors, and generated and tracked more details on change in behaviours of individuals, as well as providing an opportunity to compare these at a group level.

Research Questions

There are three levels of research questions to inform the analysis of results. These levels go from a broader focus to more targeted specific questions. Each level of analysis will be informed by the results of the previous level; this will systematically result in each aim of the study being examined.

Level 1 Main Question

What are the baseline characteristics of the whole sample and two groups of families when analysed with descriptive and exploratory statistical procedures?

Sub-questions.

1. What are the characteristics of the whole sample of infants with ISD, specifically:
    a. Categorical attachment and sleep variables?
        i. Are there any differences between attachment groups in infant and parent level secondary variables?
        ii. Are there any differences between categorical sleep groups in infant and parent secondary variables?
    b. Continuous attachment and sleep variables?
        i. Are there any correlations within attachment variables?
        ii. Are there any correlations within sleep variables?
        iii. Are there any correlations between attachment and sleep variables?
        iv. Are there any correlations between attachment, sleep, and secondary infant and parent variables?

v. What are the predictors of attachment and sleep variables in this sample?

2. What are the characteristics of families in intervention (help-seeking) and comparison (non-help-seeking) groups in terms of:
    a. Demographics: Are there any differences between groups?
    b. Sleep variables: Are there any differences between groups?
    c. Attachment variables: Are there any differences between groups?
    d. Secondary infant and parent variables: Are there any differences between groups?
    e. Can variables outlined above, if identified as statistically different for families who agreed and did not agree to receive a BSI, predict group membership when the variables analysed with discriminant function analysis?

Level 2 Main Question

Were the Behavioural Sleep Interventions (BSI) effective to resolve ISD of infants who received an intervention and how did the sleep patterns of comparison infants change through time?

Sub-questions.

1. According to the visual analysis of the time series data measured by sleep diaries;
    a. How did the sleep pattern change for infants who received an intervention in terms of the stability, level, and trend from Phase 1 to Phase 4 in their:
        i. Number of night wakings (NW)?
        ii. Duration of night wakings (NWDUR)?
        iii. The percentage of target total sleep time achieved?

b. When the average of ‘percentage of points deviating from the baseline median’ (PEM), which is the effect size measure for single case design is calculated, what is the overall effectiveness of the BSI’s for intervention infants to improve sleep pattern variables outlined above?

1. For each individual across sleep pattern variables?
2. For each sleep pattern variable?
3. Overall?

c. How did the sleep pattern change for infants who did not receive an intervention in term of the stability, level, and trend from Phase 1 to Phase 4 in their:

i. Number of night wakings (NW)?
ii. Duration of night wakings (NWDUR)?
iii. The percentage of target total sleep time achieved?

2. According to the analyses of point-per-phase sleep diary data within and across two groups using the modified Brinley Plots;

a. Was there a meaningful change in the severity of sleep problems of intervention and comparison infants measured by the Richman’s Composite Sleep Score (Richman, 1985) across phases?

b. Was there a meaningful change in the parental nighttime involvement, which was measured by the Bedtime Soothing Scale (Tikotzky & Sadeh, 2009), across phases for parents who agreed and disagreed to implement a BSI?

Level 3 Main Questions

1. Did the attachment patterns or security of infants in this sample change after receiving an intervention or through time?

2. Was the change in sleep predicted by the attachment security at baseline or influenced from the attachment security at follow up?

   a. For infants who received an intervention?

      i. Does initial attachment classification at study outset predict the sleep outcomes observed at the end of the study?

      ii. Was the attachment classification at the second assessment concurrently explained the sleep outcomes observed at the end of the study?

   b. For infants who did not receive an intervention?

      i. Does initial attachment classification at study outset predict the sleep outcomes observed at the end of the study?

      ii. Was the attachment classification at the second assessment concurrently explained the sleep outcomes observed at the end of the study?

3. According to the modified Brinley Plots, Mann-Whitney *U*-Test, and Wilcoxon Signed Rank Test, did any of the secondary infant and parent variables change across phases within and between the intervention and comparison families? What was the extent of the change in terms of the probability of superiority, which is a nonparametric effect size measure?

Method

The method section of this research will be described following the SCRIBE 2016 criteria introduced for reporting the single case research design (Tate, Perdices, Rosenkoetter, McDonald, et al., 2016; Tate, Perdices, Rosenkoetter, Shadish, et al., 2016).

Design

There were two naturally formed groups in this study: the ones who did not want to receive a behavioural sleep intervention (BSI) and ones who wanted to receive a BSI for their infants' sleep. The study used a mixed design of prospective longitudinal pre-test/ post-test and an experimental nonconcurrent single-case design with a multiple baseline across participants.

Prospective longitudinal pre-test/post-test design. Pre-test/post-test design was utilised to examine change in the quality of the attachment relationship, four to six months after the first assessment, either as a function of BSIs or through the course of time. The attachment variables were available only at two probes (the beginning and end of the experimental study) as the Strange Situation Procedure, which is explained more in detail below, can only be repeated once and no earlier than one month after the first assessment (Ainsworth et al., 1978; Solomon & George, 2016).

Single case design. A non-concurrent, randomised single case design with a multiple baseline across participants was implemented to analyse the effectiveness of BSIs in individual level (Kazdin, 2013). Single case design is an equally valid alternative to a randomised control trial to test the effectiveness of an intervention when there is no access to a large number of participants as each participant provides their own control for comparison (Blampied, 2001; Cohen, Feinstein, Masuda, & Vowles, 2014). Since a reverse design, which requires withdrawal of the treatment variable to reverse improvement behaviours, is not plausible with a behavioural sleep intervention, the multiple baseline across participants method was selected to provide evidence for internal and external validity (Cooper, Heron, & Heward, 2007). This research design has been repeatedly and successfully used in sleep literature (France & Blampied, 2005; Healey et al., 2009; Matthey & Črnčec, 2012; Selim et al., 2006).

Repeated measures were obtained in four phases within a four to six months period. The comparison group changed phase at times corresponding to those of the intervention group. Sleep measures were obtained continuously at least for seven days in each phase whereas repeated measures of secondary outcome variables were obtained point-per-phase. Four phases of the study and what they comprise for each group are explained in detail below.

Phase-1 (P-1). The first phase was the baseline for participants who received an intervention and comparison participants provided sleep measures for the same duration. All participants were randomly assigned to a baseline length of seven, 14, 21, or 28 days. Randomisation was conducted on the first day of the assessments at their clinic visit after the first SSP. Parents were asked to pick a number from one to four where one stands for seven days and four stands for 28 days. At the end of recruitment fully subscribed numbers were removed to allow equal numbers in each phase.

Phase-2 (P-2). Phase-2 corresponded to the intervention phase for the intervention group and it began on the first night of the intervention. Parents in the intervention group continued filling out the sleep diaries for several weeks until it was agreed that the program outcome was satisfactory. During Phase-2, the comparison participants continued filling out the sleep diaries for 28 days right after their allocated baseline length was over.

Phase-3 (P-3). For the intervention group, Phase-3 corresponded to the maintenance or post-intervention phase and was one week of recording, three weeks after the end of the intervention (Phase 2). The comparison group also provided one week of recording approximately three weeks after Phase-2 ended. Point-per phase measures were obtained at the home visit.

Phase-4 (P-4). A one week follow-up occurred 4-6 months after the first day of baseline, and corresponded to the timing of the second SSP. Phase-4 consisted of one week of recording for participants in both groups. Point-per phase measures were obtained at the home visit.

Blinding

The inter-rater reliability assessments of maternal sensitivity and observed negative emotionality were conducted by a Child and Family Psychology Masters student who was trained by the researcher. The inter-rater reliability of attachment measures were conducted by Elizabeth Carlson from University of Minnesota, MN, USA who is a reliable coder and one of the trainers for the SSP. Both observers were blind to families' information and group conditions. Further blinding was not possible owing to lack of financial and human resources.

Participants

Recruitment. Families with 1 year-old infants were recruited through flyers (see Appendix A) given to parental social support groups, or non-profit organisations supporting parents in the community, parenting groups on social media, and general practitioners in Christchurch, New Zealand. The flyer targeted families of infants who experience frequent night wakings and/or took at least 30 minutes to settle to sleep. The target families were invited to participate in the study by sharing their experiences and in return (a) collect an incentive (NZ$50 petrol or food voucher); or (b) receive a personalised, evidence-based behavioural sleep intervention for their infants' sleep. The recruitment process continued from February 2016 to July 2017.

Eligibility. The eligibility criteria were residing in Canterbury, speaking English, having a healthy, typically developing infant between the ages of 10-16 months, and having no other pressing problems of higher priority e.g. family or relationship problems. The target participant number was 30 in total, with 15 intervention and 15 comparison participants as ideal. Eligible families were expected to have an infant experiencing difficulties with settling and/or maintaining sleep through the night. The eligibility criterion for having a sleep problem was kept broad as maternal perception of the sleep as a problem is suggested to be sufficient (Morrell, 1999a) and the perception of having a sleep problem may vary depending on the context and cultural expectations (Mindell, Sadeh, Wiegand, et al., 2010).

Approvals. Ethical approval of this study was received from the University of Canterbury Human Ethics Committee (2015/97, Appendix B). Potential participants who approached the researcher were asked for preliminary information on the phone about their general demographics, their infant's current sleep; and their questions about the study were answered. Eligible families were then sent an electronic version of the information sheet and consent form (Appendices C and D). Following the verbal consent, their first visit to the University of Canterbury Pukemanu/Dovedale (Child and Family Psychology) Centre was arranged and written consent was obtained.

Among comparison participants, one participant did not give consent for replicating the SSP at Phase 4. Three of the comparison group participants did not give consent for the night camera installation due to cosleeping. One of the comparison participants gave consent for the night camera when she stopped cosleeping with her baby. This family's night camera recording was taken in Phases 2, 3 and 4.

Participant flow. Throughout the recruitment phase, 54 families showed their interest in the study and they were provided with detailed information about the study. Twenty-four families gave their consent and completed the Phase-1 assessments. However, only 18 of these participants (help-seeking n = 10, non-help-seeking n = 8) completed all assessments in all four phases except one participant who did not replicate the SSP. A detailed flow chart of participants is provided in Figure 1.

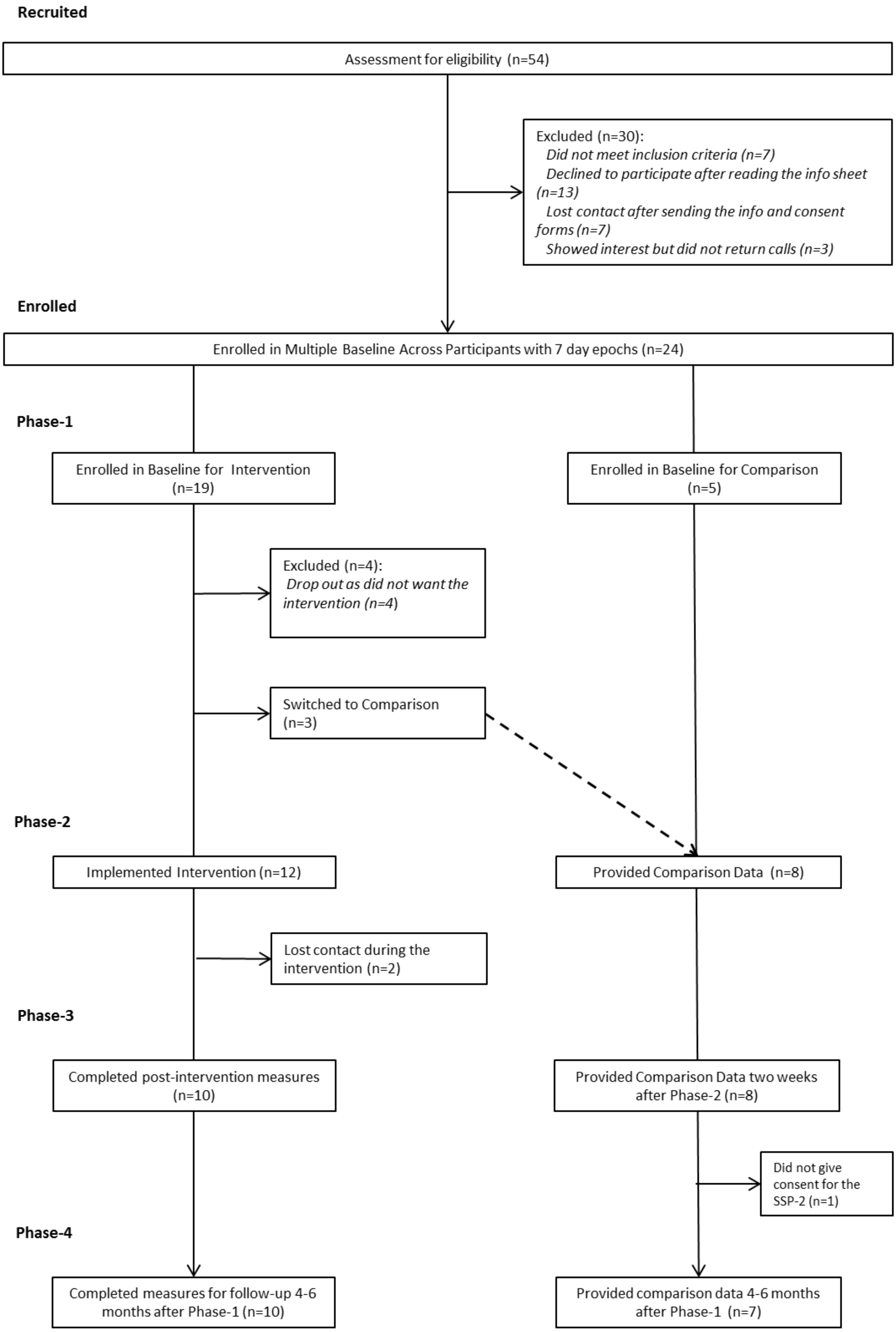

Figure 1. Participant flow chart.

Note. SSP-2 = the Strange Situation Procedure at Phase-4.

Characteristics of Participants. Characteristics of participants are explained separately for participants who provided data in Phase-1 and participants who completed all phases of the study. The Phase-1 data from 24 participants were used in the descriptive and exploratory level analysis (Level 1) and data of 18 participants who completed all phases of the study were used to analyse the single case design and pre-test post-test results (Levels 2 and 3). Phase-1 participant demographics with and without the drop-outs are provided in Table 4.

Characteristics of Phase-1 participants (with drop-outs). Out of 24 families (age range = 11-16 months, mean age = 13.16 with *SD* =1.32, 58% boys, 71% first-born) who gave their consent and completed all measures and procedures of the Phase-1, 23 were either residing or had family in Canterbury, New Zealand. Fifty eight percent of families were within the middle SES level according to the New Zealand Socioeconomic Index 2013 (Fahy, Lee, & Milne, 2017). Sixteen mothers (67%) were working either full time or part time and 50% of all children were attending day-care. The majority of parents identified as New Zealand European (both parents in 15 families (63%), and one parent in 6 families (25%)). Four families (17%) had at least one parent identified as Maori/Pacifica and in one family (~4%) both parents identified with other ethnicities. There were four single mothers in total of which three were in the comparison group. Other participants (83%) were all in stable relationships.

The primary caregiver of the infant was the mother (mean age = 32.58, *SD* = 4.91) in all families except one in which the father (age=30; fathers' mean age=34.20, *SD* = 5.93) was the primary caregiver. Since the primary caregiver is the main focus of this study, all measures in each phase were collected from the father.

At the initial contact, 21 families were interested in learning about the intervention options and five families were willing to share their experiences but did not desire an intervention. As the assessments of baseline continued, three further participants who were enrolled in the intervention group decided to switch to the comparison group.

After completing the Phase-1 assessments and receiving the set-up program interview, four participants in the intervention group decided to pull out and not to provide comparison data. Two were for time reasons, one sought intervention elsewhere, and the other infant's sleep problems were resolved just before they started the intervention.

In order to compare the demographics and characteristics of families who would want to do the behavioural sleep interventions and who would not, participants were divided into two groups based on their decision status at the end of the Phase-1. Accordingly, 13 participants were categorised as the help-seeking/intervention group (mean age = 13.19, 46 % boys, 69 % first-born) and 11 families were categorised as the non-help-seeking/comparison group (mean age = 13.12, 73 % boys, 73 % first-born).

Characteristics of participants who completed all phases of the study (without dropouts). By the Phase 4, 10 out of 12 participants in the intervention group received the intervention and completed all assessments in all phases of the study. Contact with two participants who started the intervention was lost while they were still implementing the sleep program. Therefore, Phase-2 assessments could not be obtained from these families. All comparison participants, except one, completed all measures in all phases (n = 8 for sleep and secondary outcome variables, n = 7 for attachment variables at Phase- 4).

The general demographics of these participants were similar to the participants described above (age range= 11-16 months, infants' mean age in months=13.24, SD = 1.45; mother's age range = 25-42, mothers' mean age in years = 32.44, SD = 5.44; father's age range = 26-49, fathers' mean age in years = 33.6, SD = 5.8) and details can be found in Table 4. The age of all infants at the time of SSP-2 ranged from 17.56 to 21.30 months, *Mean* = 19.18 (SD = 1.10) and Mdn = 19.06. Infants' age in intervention group ranged from 17.56 to

21.30 months, *Mean* = 19.29 (*SD* = 1.17), and *Mdn* = 19.08 and in comparison group ranged from 17.90 to 21.23 months, *Mean* = 19.03 (*SD* = 1.06), and *Mdn* = 18.80.

Sleep characteristics of these participants are provided in Tables 5, 6, 7 and 8 in the sequence of ascending baseline lengths. To protect participants' privacy, pseudonyms were assigned to these participants.

Table 4. *Characteristics of participants at Phase-1 with and without drop-outs*

	Phase-1 w/ dropouts						Phase-1 w/o dropouts					
Characteristic	Intervention		Comparison		Total		Intervention		Comparison		Total	
Number of Participants	13		11		24		10		8		18	
Infant												
Age in months (*M*, *SD*)	13.19	1.50	13.12	1.14	13.16	1.32	13.28	1.64	13.20	1.27	13.24	1.45
Female	7	54%	3	27%	10	42%	6	60%	2	25%	8	44%
First born	9	69%	8	73%	17	71%	7	70%	5	62%	11	61%
Daycare	5	38%	7	64%	12	50%	4	40%	4	50%	8	44%
Primary caregiver												
Age in years (*M*, *SD*)	32.08	4.53	33.18	5.4	32.5	4.9	31.80	5.1	33.25	6.08	32.44	5.44
Middle SES	8	61%	6	54%	14	58%	5	50%	6	75%	11	61%
Married or de facto	12	92%	8	73%	20	83%	10	100%	5	62%	15	83%
Identified as NZ EU	11	85%	7	64%	18	75%	8	80%	5	62%	13	72%
Working	9	69%	6	54%	15	62%	6	60%	4	50%	10	55%

Note. “de facto”= living together in a genuine relationship. “NZ EU”= New Zealand European, “w/” = with. “w/o”= without.

Table 5. *First five treated children's sleep characteristics at Phase-1 (corresponds to Figures 8a, 9a & 10a)*

Child (Age in mos.)	Birth order/no. siblings	Sleep disturbances reported	Age of onset (mos.)	Possible precipitating factors	Sleep location	Parent behaviours at nighttime	Previous BSI attempt(s)
Wendy (14)	1st/1	Night waking Re- settling Cosleeping	4	Change in caregiving	Cot in her own room + parents' bed	Feed to sleep, touch, cuddle @ BTS + NW Reactive cosleep	After 6 months, x2 unsuccessful attempts with health professionals
Kirk (12)	2nd/2	Night waking Re-settling	4	None	Cot in his own room	Feed @ BTS Feed to sleep @ NW	After 6 months, partially successful attempt with a health professional
Hamish (11)	1st/1	Sleep onset delay Night waking Re-settling Cosleeping	5	Transitioned to cot from hammock	Cot in his own room + parents' bed	Feed @ BTS Feed, touch, pretend asleep @ NW Reactive cosleep	After 6 months, unsuccessful self-initiated attempt
Robert (11)	3rd/3	Night waking Re-settling Cosleeping	5	Started day-care	Cot in his own room + parents' bed	Feed to sleep @ BTS Feed, rock, pat @ NW Reactive cosleep	None
Yvonne (12)	1st/1	Night waking Re-settling Cosleeping	Birth	N/A	Cot in her own room+ parents' bed	Feed @ BTS Feed to sleep, touch, rock, sit beside cot @ NW Reactive cosleep	After 6 months, partially successful attempt with a health professional

Note. Feed @ BTS= breastfed or bottle fed during bedtime settling but put in bed awake, Feed @ BTS + NW= breastfed or bottle fed during bedtime settling and night awakenings but put in bed awake, Feed @NW= breastfed or bottle fed at night awakenings but put in bed awake, Feed to sleep @ BTS+NW= breastfed or bottle fed to sleep at bedtime settling and at night awakenings, N/A=not applicable, Re-settling= Difficulty with resettling to sleep after a night wake.

Table 6. *Second five treated children's sleep characteristics at Phase-1 (corresponds to Figures 8b, 9b & 10b)*

Child (Age in mos.)	Birth order/no. siblings	Sleep disturbances reported	Age of onset (mos.)	Possible precipitating factors	Sleep location	Parent behaviours at nighttime	Previous BSI attempt(s)
Hannah (12)	1st/1	Fear of cot Sleep onset delay Night waking Re-settling Cosleeping	Birth	N/A	Parents' bed	Feed, cuddle & walk @BTS Feed, pat, shush @ NW Reactive cosleep	After 6 months, unsuccessful self-initiated attempt
Rebecca (16)	2nd/2	Night waking Re-settling	13	Stopped nocturnal breastfeeding	Cot in her own room	Feed to sleep @ BTS Pick up/cuddle/put down, touch, sit beside cot @NW	After 13 months, unsuccessful attempt with a health professional
Mike (14)	1st/1	Night waking Re-settling	12	Fed at NW when standing in cot	Cot in his own room	Feed to sleep @ BTS Feed to sleep, touch, ignore @ NW	None
Robyn (14)	2nd/2	Sleep onset delay Night waking Re-settling Cosleeping	Birth	N/A	Parents' bed	Feed, cuddle & walk @ BTS Feed to sleep, touch, rock @ NW Reactive cosleep	After 6 months, unsuccessful self-initiated attempts x3
Sheryl (12)	1st/1	Night waking Re-settling Cosleeping	Birth	N/A	Cot in her own room + parents' bed	Feed to sleep, pacifier, rock, pat, shush @ BTS + NW Reactive cosleep	None

Note. Feed @ BTS= breastfed or bottle fed during bedtime settling but put in bed awake, Feed @ BTS + NW= breastfed or bottle fed during bedtime settling and night awakenings but put in bed awake, Feed @NW= breastfed or bottle fed at night awakenings but put in bed awake, Feed to sleep @ BTS+NW= breastfed or bottle fed to sleep at bedtime settling and at night awakenings, N/A=not applicable, Re-settling= Difficulty with resettling to sleep after a night wake.

Table 7. *First four comparison children's sleep characteristics at Phase-1 (corresponds to Figures 11a, 12a & 13a)*

Child (age in mos.)	Birth order/no. siblings	Sleep disturbances reported	Age of onset (mos.)	Possible precipitating factors	Sleep location	Parent behaviours at nighttime	Previous BSI attempt(s)
Leila (13)	1st/1	Night waking Re-settling	Birth	N/A	Cot in her own room + mattress in her room with parent	Feed to sleep @ BTS Feed, rock, touch, ignore @ NW Reactive cosleep	After 6 months, partially successful self-initiated attempt
Harrison (12)	3rd/3	Night waking	Birth	N/A	Parents' bed	Feed to sleep @ BTS +NW Intentional cosleep	None
William (12)	2nd/2	Sleep onset delay Night waking Re-settling	Birth	N/A	Parents' bed	Feed to sleep @ BTS +NW Intentional cosleep	None
Alan (13)	1st/1	Sleep onset delay Night waking Re-settling Cosleeping	Birth	N/A	Cot in his own room + Parents' bed+ Pram in living room	Cuddle & sing @ BTS Feed to sleep, rock, sing, touch, sit beside cot @ NW Reactive cosleep	After 6 months, unsuccessful self-initiated attempt

Note. Feed @ BTS= breastfed or bottle fed during bedtime settling but put in bed awake, Feed @ BTS + NW= breastfed or bottle fed during bedtime settling and night awakenings but put in bed awake, Feed @NW= breastfed or bottle fed at night awakenings but put in bed awake, Feed to sleep @ BTS+NW= breastfed or bottle fed to sleep at bedtime settling and at night awakenings, N/A=not applicable, Re-settling= Difficulty with resettling to sleep after a night wake.

Table 8. *Second four comparison children's sleep characteristics at Phase-1 (corresponds to Figures 11b, 12b & 13b)*

Child (age in mos.)	Birth order/no. siblings	Sleep disturbances reported	Age of onset (mos.)	Possible precipitating factors	Sleep location	Parent behaviours at nighttime	Previous BSI attempt(s)
Mere (11)	4th/4	Sleep onset delay Night waking	Birth	N/A	Parents' bed	Feed to sleep @ BTS + NW Intentional cosleep	None
Scott (12)	1st/1	Night waking	Birth	N/A	Cot in parents' room	Feed, dummy, cuddle & rock @ BTS + NW	None
Peter (16)	1st/1	Sleep onset delay Night waking Night time settling	Birth	N/A	Cot in his own room + parents' bed	Feed, cuddle, pretend asleep @ BTS Feed to sleep, change nappy, cuddle @ NW Reactive cosleep	After 6 months, sleep hygiene with a health professional
Ben (13)	1st/1	Sleep onset delay Night waking Night time settling	Birth	N/A	Parents' bed	Feed to sleep @ BTS + NW Intentional cosleep	None

Note. Feed @ BTS= breastfed or bottle fed during bedtime settling but put in bed awake, Feed @ BTS + NW= breastfed or bottle fed during bedtime settling and night awakenings but put in bed awake, Feed @NW= breastfed or bottle fed at night awakenings but put in bed awake, Feed to sleep @ BTS+NW= breastfed or bottle fed to sleep at bedtime settling and at night awakenings, N/A=not applicable, Re-settling= Difficulty with resettling to sleep after a night wake.

Settings

The study was conducted in Christchurch, New Zealand and data collection continued from February 2016 to November 2017. The measures and assessments were conducted in the Pukemanu/Dovedale Centre at the University of Canterbury, and in participants' home settings. The intervention took place in participants' homes at night time and was conducted by the parents themselves.

Clinic visits. Participants attended the Pukemanu/Dovedale Centre up to four times during the course of the study to complete the Strange Situation Procedure (twice), clinical intake interview, program set-up interview and the evaluation/ feedback interview. When participants first visited the clinic, the Strange Situation Procedure (SSP-1) was conducted first and after a short break, parents were invited to the clinical intake interview. If it was not possible to complete both assessments in one day, parents would be invited back for a second time. Closer to the end of their baseline length, participants choosing an intervention were invited to the clinic for the set-up program interview in which the sleep program was negotiated with the family. The last time they visited the clinic was at the end of the study when they completed the SSP again. Following this, an evaluation/feedback interview was held where their opinions about the program and the study were discussed and the Parent Evaluation Questionnaire was completed. An attempt was made to provide a novel environment for the SSP-2 however, construction noises around the alternative building meant this option was abandoned after two participants.

Home visits. Home visits were conducted within the first 2 weeks of Phases 1 and 2; and within Phases 3 and 4. Up to 8 home visits were conducted for each family. Aims of the home visits were (a) to video-record a 15-minute parent-infant free play to measure parental daytime sensitivity and infant negative emotionality, (b) have the parent fill out the self-report questionnaires, (c) set up the night camera by the infant's cot or parent's bed, (d) check parents' progress with the sleep diaries, (e) support families in intervention group and answer questions or hear concerns. A second or subsequent visit was to collect the night camera after 3 consecutive nights of recording and eliminate any problems with video recordings or missing data.

Materials

Sleep diaries. The sleep diaries were adapted from France and Hudson (1990) and printed as a booklet on A4 paper (Appendix E) with instructions and an example page. Each page had separate sections to collect information on: (1) time, number, and duration of day naps; (2) bedtime settling information (place of sleep, time of bedtime settling, time from put down to silence and the nature of sounds such as cry, and what they did to settle their infant to sleep); (3) information on each night awakening (the time, the duration, the nature of sounds, what they did to settle their infant to sleep); and (4) the up time for the day. The sleep diaries were explained to parents during the clinical intake interview at Phase-1. The filled out diaries were collected at each home or clinic visit or occasionally through email.

Video Equipment. Three different kinds of video equipment was used for the purposes of recording the SSP, the parent-infant free play interaction, and infants' sleep at night time. The SSP was recorded through the standard camera of the Pukemanu/Dovedale Centre clinic room.

A hand camera, Canon Legria HF20, was used to record the 15 minutes free-play interaction at home visits. This allowed the researcher to follow the dyad around their home as required.

The night camera was an infra-red light surveillance camera (D-Link DCS-2132L) and it was placed over the infants' crib for 3 consecutive nights. The camera was set up, without internet connection, through an Ethernet cable plugged into one particular laptop with the software program. The camera settings were arranged beforehand to work for 12 hours each night and the nighttime was negotiated with parents. For example, if the child was put to bed at 7pm, the night camera would work from 7pm to 7am for 3 consecutive nights without any parent involvement. The images and the video were recorded into a micro SD card of 35GB. Images included the child in the cot and the sounds in the room. When the child and the parent were cosleeping in parents' bed, the camera was arranged to capture the infant first but sometimes included the one side of the bed that the primary caregiver slept in.

Measures

There were primary and secondary outcome variables in this study in infant, parent, and infant-parent interaction domains. Both direct and indirect measurement tools were used. Demographic and family background information, sleep history, current sleep and sleep location were obtained through clinical intake interview. Infant-level information was also gathered from the parent self-report Infant Characteristics Questionnaire (ICQ). Parents provided information through the self-report Maternal Cognitions about Infant Sleep Questionnaire (MCISQ), Depression, Anxiety, and Stress Scale-21 Item version (DASS-21).

Direct observational methods were used to measure Infant Negative Emotionality and Parent Daytime Sensitivity during the 15 minutes infant-parent free-play using the adapted Child Behaviour Scale (Appendix F) and Mini-Maternal Behavior Q-Set-V Revised (Mini-MBQS-V Revised). On the parent-infant interaction level, The Strange Situation Procedure (SSP) was conducted to obtain attachment variables. The Sleep Diary was the main resource for both infant and parent sleep-related variables. The videosomnography was used to test the reliability of the sleep diaries. Table 9 provides details of each dependent variable (DV), measures and procedures in each phase. The variables and measures will be explained in the same order.

Table 9. *Dependent variables, assessment settings and durations in each study phase*

Dependent Variables			Settings, Procedures, and Assessment Durations in Each Study Phase			
Domain	Variable	Materials and Outcome Measures	Phase-1	Phase-2	Phase-3	Phase-4
Infant-parent interaction	The Quality of Attachment Relationship	*The Strange Situation Procedure (SSP)*: Attachment Resistance (via Interactive Attachment Behaviours Scale), Attachment Security (continuous score via modified Richters' Formula), The Normative Attachment Patterns (ABC), B4/Non-B4 and Secure/Insecure Dichotomous categories	SSP-1 at Pukemanu-Dovedale Centre as the first assessment of the study	-	-	SSP-2 at Pukemanu-Dovedale Centre, 4-6 months after the SSP-1
Infant	Sleep Pattern	*Sleep Diary*: NW, NWDUR, % of the Target Duration of Total Sleep. Reliability via *VSG*: Infra-red time lapse video equipment put beside infant's cot.	1-5 weeks +3 nights VSG	4-6 weeks+3 nights VSG	1 week +3 nights VSG	1 week+3 nights VSG
	The Severity of Sleep Problems	*Richman's Composite Sleep Score (CSS)* calculated from the Sleep Diary data	last week (w/o sick or missing day)	last week (w/o sick or missing day)	last week (w/o sick or missing day)	last week (w/o sick or missing day)
	Observed and Perceived Negative Emotionality (NE)	Perceived NE: *ICQ* fussy/difficult subscale, adapted for 12 month-old infants	Parent report at Home Visit	Parent report at Home Visit	Parent report at Home Visit	Parent report at Home Visit
		Observed NE: a) Frequency of behaviours coded in 15sec intervals b) Overall rating on a 4-point scale (NE Scale)	15- mins mother-infant free-play at Home Visit	15- mins mother-infant free-play at Home Visit	15- mins mother-infant free-play at Home Visit	15- mins mother-infant free-play at Home Visit
		Cry Duration at SSP Separation Episodes coded in 15 sec intervals during Episodes 4, 6 & 7	SSP-1 at Pukemanu-Dovedale Centre	-	-	SSP-2 at Pukemanu-Dovedale Centre
Parent	Parental Nighttime Involvement	*Bedtime Soothing Scale (BSS)*: the intensity of parent involvement at bedtime and nighttime on a 5-point scale from the behaviours parents reported for each night on Sleep Diary.	Averaged for the CSS days	Averaged for the CSS days	Averaged for the CSS days	Averaged for the CSS days
	Parental Daytime Sensitivity	*Mini-Maternal Behavior Q-Set for Video coding- Revised (Mini-MBQS-25-V Revised)*: Global Score of Sensitivity	15- mins mother-infant free-play at Home Visit	15- mins mother-infant free-play at Home Visit	15- mins mother-infant free-play at Home Visit	15- mins mother-infant free-play at Home Visit
	Parental Cognitions about Infant Sleep	*MCISQ*: Total score and Subscales (*Difficulty with Limit Setting, Anger, Doubt, Feeding beliefs, and Safety concerns)*	Parent report at Home Visit	Parent report at Home Visit	Parent report at Home Visit	Parent report at Home Visit
	Parental Wellbeing	*Depression Anxiety Stress Scale (DASS-21):* Total score and subscales	Parent report at Home Visit	Parent report at Home Visit	Parent report at Home Visit	Parent report at Home Visit

Note: ABC= Avoidant, Secure, Ambivalent/Resistant attachment patterns. B4 = secure attachment category with high resistance score. CSS = Richman's Composite Sleep Score. DASS-21 = Depression, anxiety, and stress scale 21 item version. ICQ = Infant Characteristics Questionnaire. MCISQ = Maternal cognitions about infant sleep questionnaire. NE = Negative Emotionality, NW = Number of night wakings per night, NWDUR = Duration of night wakings per night. SSP = Strange Situation Procedure. VSG = Videosomnography. w/o =without.

Infant-parent interaction variables and measure.

The Strange Situation Procedure (SSP). The quality of attachment relationship was measured with the SSP which was developed by Ainsworth (1978) and considered as the 'gold standard' measure of 12-20 months-old infants' attachment (van IJzendoorn & Kroonenberg, 1988). The purpose of the situation is to expose the infant in a strange room with a strange female and gradually increase the stress to have attachment behaviours triggered and ready to be observed (Sroufe & Waters, 1977). There are eight episodes in 22 minutes with three separation (episodes 4, 6, and 7) and two reunion episodes (5 and 8).

The SSP has been widely used in many countries and the reliability and validity information were provided in various studies through the years (van IJzendoorn & Kroonenberg, 1988). According to the systematic review by Tryphonopoulos, Letourneau, and Ditommaso (2014) the internal consistency (α) was reported to be between .78-.88 and inter-rater agreement was reported to be between 70-100% in ABC classifications and 80-100% for D classification (Carlson, 1998; Solomon & George, 2016). Cross-cultural consistency was also evident based on the percentage of secure attachment being at least 50% in studies from Africa, South Asia, and North America (Mesman et al., 2016).

The concurrent and predictive validity of the SSP has been established through many longitudinal studies such as the Minnesota Longitudinal Study (Sroufe et al., 2005) and the NICHD Study of Early Child Care (1997). The construct validity of the measure is still underway, as no other measure to make a fair comparison has been developed yet (Solomon & George, 2016). However, there are two restrictions to the concurrent validity of the Ainsworth's coding system for organised attachment (ABC), which are the replication and age restriction. Firstly, when the SSP was replicated two weeks after the first assessment, there were disrupted reactions observed in children (Ainsworth et al., 1978). Nevertheless, there was a reasonable stability in the classifications when replicated after 6 months (Waters, 1978). Secondly, as children get older, they tend to use their communication skills more to mediate their interactions with their caregiver in stressful situations (Ainsworth et al., 1978). Therefore the sensitivity of the measure to classify attachment sub-categories through interactive behaviours decreases (Richters, Waters, & Vaughn, 1988). To overcome these two obstacles, the suggested latest age the SSP could be conducted was followed, which is 21 months (van IJzendoorn & Kroonenberg, 1990) and the assessment was replicated at least four months after the first assessment (A. Sroufe, personal communication, August 2015).

The procedure was conducted in the standardised clinic room of the Pukemanu/Dovedale Centre with an adjacent observation room. In order to have a reliable assessment, the procedure requires three roles to be present which are the stranger, the instructor/experimenter, and the camera controller. The Child and Family Psychology postgraduate program students and clinical trainers were trained by the researcher for the roles of the stranger and the instructor. SSP-2 for each child was conducted with a different stranger from the one in SSP-1. The parents were provided with detailed information on the procedure (Appendix G) and were handed cue cards for each episode which they could refer to while in the room. During the separation episodes, parents had the chance to view their child from the observation room. Each episode was 3 minutes long, however, the separation episodes were cut shorter if the child became very upset and/or when the mother requested so after the first 30 seconds.

The SSP needs to be implemented and coded by trained researchers and 25% of the cases need to be coded by a blind, reliable coder (Solomon & George, 2016). For training purposes, the senior supervisor, Associate Professor Karyn France received a Canterbury Medical Research Foundation Grant-in-Aid funding enabling the researcher to go to the University of Minnesota for two weeks to receive the SSP training from Alan Sroufe and

Elizabeth Carlson in August 2015. The researcher was trained in the ABCD coding system and received reliability certification in coding organised ABC patterns on 24 February 2018. Figure 2 provides a summary of the SSP coding process in hierarchical order and demonstrates the decision flow to generate the attachment variables for this study.

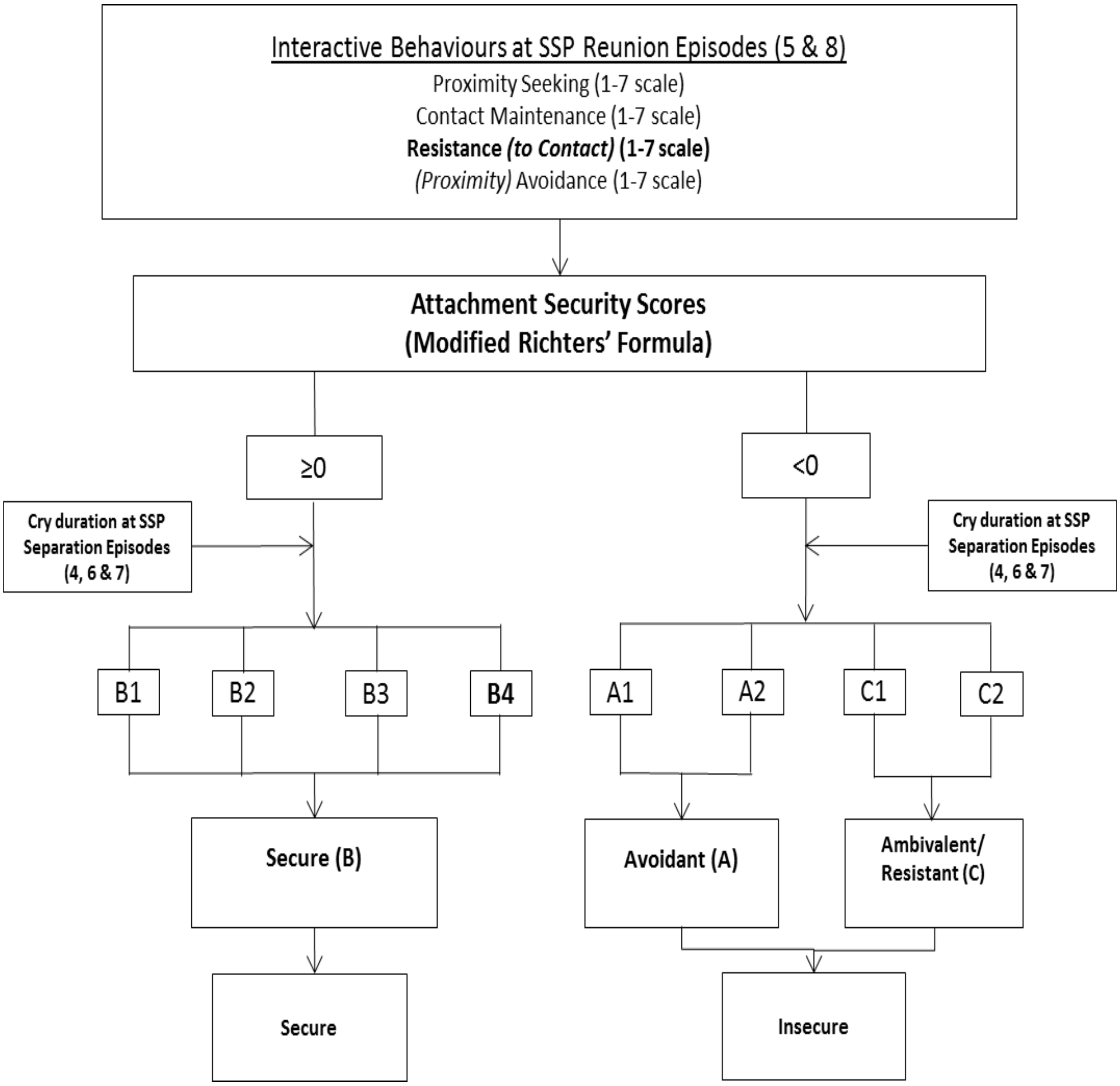

Figure 2. Decision flow for generating attachment variables.

*Not*e. Variables included in the analyses were indicated with bold letters.

Interactive attachment behaviours. The coding process began with scoring each reunion episode (episodes 5 and 8) using the Ainsworth's Interactive Behaviours Scales (1978). The scales describe and rate groups of behaviours which are organised in order to achieve the goal: maintaining proximity and maximising the chances of receiving care and safety from the caregiver. These scales are 'proximity seeking', 'contact maintenance', '(proximity) avoidance' and 'resistance (to contact)'. Each scale is assigned a score from one to seven based on the frequency, strength, significance and timing of goal-corrected behaviours. Score one is given when these behaviours are not observed and seven is saved for the behaviour organisation that was very strong, distinct, long, or visible throughout the reunion episode. Eventually, each child receives two scores of each interactive behaviour scale. Among these scales, the Resistance scores of participants was a particular interest for this study because it was positively associated with infant sleep problems in the meta-analysis (Simard et al., 2017).

Attachment security score. The security of the infant attachment was calculated as a continuous score with the formula developed by Richters et al. (1988). The formula was developed from the Interactive Behaviours Scale scores of Ainsworth's original sample combined with a few other samples and they used these scores to predict the attachment classification by putting them into a discriminant function analysis. Later, this formula was modified to generate a continuous attachment security score (van IJzendoorn & Kroonenberg, 1990) and named as the modified Richters' Score. This is a continuous score where a score above zero represents a secure attachment and scores below zero represent an insecure attachment. The formula can further be utilised to calculate the exact classification of insecure attachment (A or C).

Normative attachment patterns: Avoidant (A), Secure (B), Ambivalent-Resistant (C). Based on the scores infants received on the Interactive Behaviours Scales, a classification was assigned to the infants' attachment organisation. According to Ainsworth's classification system, infants can be categorised into two A (insecure-avoidant) categories (A1 and A2), four B (secure) categories (B1 to B4), and two C (insecure-ambivalent) categories (C1 and C2) based on the variety of individual differences displayed during the procedure. Since the number of participants in each category was very small, the three main categories (A-B-C) were used in the analysis. However, the frequency of infants with B4 pattern was demonstrated specifically because these infants were suggested to present with sleep problems (Bélanger et al., 2015).

Inter-rater reliability of SSP. The inter-rater reliability coding for the attachment variables were conducted by Elizabeth Carlson, PhD in the University of Minnesota, Minneapolis, US for 25% of all SSP videos (n = 10) and the results indicated high agreement. The between-percentage agreement for ABC coding was 70% (Cohen's *Kappa* = .538, p=.010 <.05). The intra-class correlation (ICC) for attachment resistance scores was .86 (p = .000) with the Cronbach's α = .92. The ICC for attachment security scores which is calculated from the modified Richters' Formula was .80 (p = .002) with the Cronbach's α =.89.

Demographics and family background information. Demographics and family background information, specifically sleep history, current sleep and sleep location, were obtained through the clinical intake interview which is a standard intake interview used in the Pukemanu/Dovedale Centre (Appendix H). The details of this interview will be explained in the interventions section.

The infant level demographic information included age, gender, parity and day-care attendance. Parent level information included age, socio-economic status, ethnicity, relationship and working status and results were compared for the two groups. Current sleep and sleep history information included the age of onset of sleep problems, night time breastfeeding, and previous experiences with behavioural sleep interventions.

Parents were also asked about their infants' sleep location and whether they were happy with the current arrangement. Cosleeping was defined as bed-sharing or sleeping in the same room with the infant. The parent responses were divided into 'intentional' cosleeping, 'reactive' cosleeping and no cosleeping (baby sleeping in his/her cot in his/her room) categories. The terminology was suggested by Messmer, Miller, and Yu (2012) in order to differentiate parents who cosleep as a reaction to their infants' unwanted frequent night wakings and use it as a coping strategy from parents who intentionally and willingly choose to cosleep with their infants (Stewart & Riegle, 2014).

Infant variables and measures.

Sleep pattern.

The Sleep Diary. The sleep patterns of the infants were measured with the Sleep Diary which is considered to be reliable and valid when compared with objective sleep measures (Sadeh, 2015). Infant sleep variables generated from the sleep diary were the target behaviours to change in the intervention group.

Number of night wakings (NW). The total number of awakenings per night were calculated as the main variable since all infants were reported to experience night wakings at Phase-1. A night waking was defined as "any noise from the child, sustained for at least 1 minute, heard by the parent between the time child has first settled to sleep to the agreed up time for the day" (France & Hudson, 1990, p. 92).

Duration of night wakings (NWDUR). The total duration of night wakings per night were calculated in minutes from parents' recorded times and durations in the sleep diary from the time infant first settled to sleep to the time up the next day.

Percentage (%) of the Target Duration of Total Sleep. This was defined as the percentage of target total sleep the infant achieved for one night when the total duration of night sleep was divided by 12 and multiplied by 100. The total sleep duration was calculated from the time the infant first settled to sleep to the up time for the day minus the total duration of wakings during the night. The target duration of total sleep was set to be 12 hours in accordance with the developmentally expected total sleep durations of infants in their second year of life (Hirshkowitz et al., 2015). As infants' self-soothing skills increase in time, they tend to signal less, therefore the sleep duration reported by parents tends to increase as well (Sadeh, 1994). For this reason the % of the target duration of total sleep was considered as an indicator of increase in the capacity to return oneself to sleep after a partial arousal which is key to being an independent sleeper (Blampied & Bootzin, 2013).

Reliability via Videosomnography (VSG). Videosomnography is a standard technique used in infant sleep research (France & Blampied, 2005; Healey et al., 2009; Henderson et al., 2010; Sadeh, 2015). At least 3 phases of night camera recordings were fully available for only 6 participants in the intervention group and 3 participants in the comparison group due to technical difficulties experienced throughout the study. The VSG data were coded from two nights in each phase by a Psychology Master's thesis student. The sleep diaries and the VSG were compared for (1) time the infant was put down in bed; (2) time the infant was out of the bed (either up for the day or taken to parents' bed); (3) number of signalled night wakings; (4) total duration of signalled night wakings. There was a 15 minutes allowance for a difference between parents' records and the time registered on the video coding. The overall percentage of agreement between VSG and sleep diaries were 90.75% for the intervention group and 87% for the comparison group. Parents showed the least accuracy in recording the total duration of night wakings (75% in the intervention group and 81% in the comparison group) and showed the most accuracy in recording the number of night wakings (100% in both groups).

The severity of sleep problem (Richman's Composite Sleep Score-CSS). Since initial eligibility was based on mother's perception of their infant's sleep, objective criteria were necessary to define the severity of the sleep problems of infants in this study. This was also necessary to track and summarise changes in infants' sleep after intervention or over time. The Richman criteria are widely used in the literature as the objective criteria for having a sleep problem in infancy (Alamian, Wang, Hall, Pitts, & Ikekwere, 2016; Minde et al., 1993; Morrell, 1999a). In the light of these criteria, a composite sleep score can be calculated from the sleep diary data as a summary of an infant's and their parents' nighttime behaviours.

The Richman's Composite Sleep Score (CSS) is advised to be calculated from sleep diaries completed by parents for two weeks (Richman, 1981, 1985). As the shortest duration of baseline was seven days, Richman's CSS was calculated for each infant from the last seven days of each phase, without missing data or sick days.

The CSS sub-scales comprise (a) average time taken to sleep or average bedtime; (b) average total time slept at night in hours; (c) average number of nights waking per week, (d) average number of wakings per night; (e) average time awake per waking; and (f) average weekly hours in parents' bed. The scores for each scale are ordinal from 0 to 4 indicating increased severity and these were summed up to receive the CSS. The highest score is 24. The Cronbach alpha calculated by Minde et al. (1993) for internal consistency was .768 which can be considered marginal.

In Richman's original article (1981), the mean score of 1 to 2 year-old (mean age = 21.1) children with sleep problems was 10.6; and 12 was considered as the cut-off for an indicator of severe sleep problems (Richman, 1981, 1985). Morrell (1999a) furthered this in his study to test the validity of a new measure and accepted eight as the cut-off score to discriminate 13-months-old infants showing sleep problems based on mean and standard deviations reported by Minde et al. (1993). Therefore in this study, eight was taken as the cut off score for children displaying sleep problems.

Observed and perceived negative emotionality (NE). Both subjective and objective measures of negative emotionality were obtained. The temperament of an infant is a broad construct, and these were chosen as aspects of temperament likely to be relevant to sleep (Karraker, 2008). Best practice for objectively measuring temperament is a laboratory experiment (Kagan, 2010), however, this was beyond the means of this study. An alternative objective way of measuring temperament was chosen.

The fussy/difficult subscale of Infant Characteristics Questionnaire (Bates, Freeland, & Lounsbury, 1979), was used to measure parent's perception of their infant's difficulty. As the objective measure, the 15 minutes video recording of mother-infant free-play interaction was coded by using an adaptation of the Child Behaviour Rating Scale's negative emotionality subscale (NICHD Early Child Care Research Network, 2004). To triangulate the measures, the duration of infant's crying during the three separation episodes of the Strange Situation Procedure, which are suggested to correlate with parental temperamental measures (Sroufe et al., 2005), were calculated.

Infant Characteristics Questionnaire (ICQ). Perceived negative emotionality was measured with the ICQ which was developed by Bates et al. (1979), validated for the New Zealand population (Siegert, Scannell, & Parr, 1994) and was used in previous sleep studies (Morrell & Steele, 2003; Sagi et al., 1994; Scher, 2001a; Scher & Asher, 2004). The original fussy-difficult subscale of ICQ was generated for 6 months old infants and consisted of nine items in 7-point Likert scale. Among these items, only six of them were loading on the fussy/difficulty factor for 13 months old sample (Lee & Bates, 1985). As part of a combined measurement kit for negative emotionality, Blair (2002) adapted the ICQ fussy/difficult subscale for 12 months old infants and selected five items of the questionnaire which loaded on the difficultness factor more than the other items. These items were "how much fuss/cry in general (.73), overall difficulty (.71), how easily get upset (.55), how changeable baby's mood (.59), general mood (.53). The internal consistency of this version of the subscale was (Cronbach's α) .71. In this study, parents completed the original version of the ICQ, however, the analysis of the perceived negative emotionality was therefore calculated from Blair's adaptation.

Observed negative emotionality. During the home visit, a 15-minute-free-play interaction between the parent and infant was video-recorded. The instruction to the parent was to "play with the infant as they would normally do". There were no restrictions around toys or the environment therefore the dyad could use any place of their home and the researcher could follow the dyad. The fussy, uncooperative, stressed and difficult behaviours during a neutral free play with the mother when the infant is fresh (fed and slept) was previously used as an indicator of negative emotionality in the United States-origin longitudinal study called NICHD Study of Early Child Care (NICHD Early Child Care Research Network, 1997, 1999, 2004). This measure was reported to be significantly stable from six months to three years of age and had strong predictive associations with later behavioural and emotional problems (Troxel et al., 2013).

In NICHD longitudinal study, the infant negative emotionality was scored by two independent, blind coders with a 1 to 4 scale; in which one was no sign of negative mood and four was high level of fussiness and stress. The interrater reliability was also established with a third coder which was reported to be .83 at six months and the intra-class correlation was .90 (NICHD Early Child Care Research Network, 2004; Troxel et al., 2013).

Since there was only one researcher to code videos, this method needed to be more objective. Therefore, the NE was first coded into discrete events observed during the free-play interaction video. Four groups of negative behaviours, namely, cry, fusses, hitting/ throwing or kicking toys or the parent, and actively rejecting parent's bids for interaction, were coded from video records (Appendix F). Observed behaviours were counted as discrete events of up to 15-second duration. The number of coded behaviours were summed and analysed for two groups. Hypothetically, the highest score would be 60 in the case of a child having a tantrum for 15 minutes (which never happened) and zero would be given if there was no sign of visible negativity.

After the video was coded for discrete events, the researcher gave an overall negative emotionality score in a 1 to 4 scale, using the same criteria used in NICHD studies. There was a positive, significant correlation between observed frequency of negative emotionality and the negative emotionality in the 4-point scale (r = .910, p<.001).

Reliability of Observed NE measures. A Child and Family Psychology Master's thesis student, who was blind to the group allocation, coded the randomly selected 19 videos. The agreement was within satisfactory range for the observed frequency of negative emotionality. The intra-class correlation coefficient was .835 and Cronbach's α was .835. The Cohen's *Kappa* for the Negative Emotionality in the 4-point scale indicated a good agreement as well (*Kappa* = .711, p<.0001).

Cry durations at the SSP separation episodes. In addition to perceived and observed negative emotionality, infant's cry duration during the SSP separation episodes were calculated and included in the analysis. As crying is one of the major complaints in the literature and suggested as a reason why parents may not want to do a BSI (Blunden & Baills, 2013), it was considered that, since the separation episodes are a small experiment on the level of protest the parent receives as a reaction to being left alone (or with a stranger) it might be a good indicator of either the separation anxiety level displayed by the infant (Weinraub et al., 2012) or the level of self-regulation the infant displayed. There are a few studies indicating that the cry duration during SSP separation episodes might indicate differences in self-regulation (Riva Crugnola et al., 2011) as well as differences in negative reactivity (Braungart & Stifter, 1991).

The duration of crying during SSP separation episodes 4, 6, and 7 are coded in 15 seconds intervals and gets a score from 1 to 12; higher scores indicating longer duration of cry (Ainsworth et al., 1978). Sometimes the separation episodes were cut short when the infant cried intensely and continuously. In these cases, remaining number of intervals were added onto the counted intervals with crying during the episode.

Parent variables and measures.

Parental nighttime involvement. Parents' interactions with their infant during nighttime were derived from their records on the Sleep Diary. As there were participants who only coslept with their children, the frequency of nighttime behaviours were not sufficient to indicate individual differences in parental involvement at nighttime. Therefore, an intensity of nighttime involvement measure, The Bedtime Soothing Scale (BSS) was chosen to be used.

The BSS was developed by Tikotzky and Sadeh (2009) and successfully used to calculate the intensity of parents' involvement with soothing their baby at bedtime and night time. The longitudinal outcomes of the original study was also presented in Tikotzky and Shaashua (2012). In their study, the parental involvement decreased in time as expected, however, the stability of the scores for the night wakings scale from night to night at 12 months was moderate (Cronbach's α = .68).

The Bedtime Soothing Scale consisted of two 5-point-rating scales: one for bedtime interactions and one for the night wakings. The bedtime interactions scale items were "(1) in crib, by him/herself, without caregiver help; (2) In crib, with parents' passive *presence* (without talking, touching, etc.); (3) In crib, with brief parental help for less than 2 minutes (e.g. minimal check); (4) In crib, with parental extended help; (5) While nursing, feeding, drinking or outside the crib with a caregiver's active help, or falling asleep in parents' bed". The night time interactions intensity scale items were "(1) No parental involvement (ignoring); (2) Passive parental presence; (3) Drink or brief parental help in crib for less than 2 minutes; (4) Extended parental help in crib; (5) Nursing, feeding or soothing outside the crib or soothing in parents' bed."

If there was more than one strategy used during one night, the option with the highest score is selected as the rating of the night. These scores were calculated for each night on each phase for both groups. The treatment integrity was calculated from the percentage of nights parents' BSS scores were ≤ 3 during Phase-2 when the infant was not sick. Further, an average score for each phase was calculated by combining the bedtime and nighttime scales from the same seven days the Richman's CSS was calculated from. This average score was included in the data analysis of sleep variables. A cut-off score of (3) for low involvement was selected to accommodate the fact that some interventions required parents to be shortly present in the infants' room and reassure the infant for a few seconds while the infant stayed in the cot.

Parental Sensitivity at Daytime. The quality of parents' daytime interaction with their infant was measured using the revised version of the mini-Maternal Behavior Q-Set (25 item, mini-MBQS-V Revised for video coding) (Moran, Pederson, & Bento, 2009) which is freely available online. The original 90-item MBQS, which has been widely used (Behrens, Hart, & Parker, 2012; Mesman & Emmen, 2013), was developed by Pederson et al. (1990) from Ainsworth's original scales (Ainsworth et al., 1978) to assess mothers' responses to their infants during a natural observation in their home setting.

Each item has a criterion score ranging from 1 to 9, which was assigned by 10 professionals, to represent the most like prototypically (9) to the least like prototypically sensitive mother (1). Items describe a parent's behaviours to illustrate its appropriateness, timeliness and consistency in responding to the infant's signals and needs (Pederson & Moran, 1995b). The aspects of the interaction covered in these items are parental affect (e.g.

“Distressed by B.’s demands”), interaction style (e.g. “Interactions revolve around B.’s tempo and current state”), attentiveness (e.g. “Responds to B.’s signals”), and communication skills (e.g. “Praises B.”) (Pederson & Moran, 1995a).

The Mini-MBQS-V was specifically developed for coding the video-recorded mother-infant interactions either in home or laboratory settings when natural observation was not feasible for research purposes (Moran, 2009). Twenty five items of the original MBQS were selected to represent both ends of the spectrum in a balanced way (Tarabulsy et al., 2009). The items were advised to be printed on q-cards and the observer is expected to divide them into 5 piles where (1) indicating behaviour that least likely to represent the parent and (5) indicating the behaviour that most likely to represent the parent (Moran et al., 2009).

The parent’s sensitivity score is calculated from the Pearson’s correlation coefficient between the observer’s score that is descriptive of the parent’s behaviour and the criterion score of the item (Pederson & Moran, 1995b). The sensitivity score ranges from -1.0 (the least sensitive) to 1.0 (the most sensitive). The inter-rater reliability (r_i = .94, p<.0001) and the convergent validity of the Mini-MBQS-V against the 90-item MBQS 3.0 (r = .35, p<.05) was established (Tarabulsy et al., 2009). The Mini-MBQS-V Revised was published later in the same year (Moran et al., 2009) in order to increase the validity of the same measure as some of the selected items were impossible to observe through videos. In a recent study (Bailey, Redden, Pederson, & Moran, 2016) the inter-rater agreement of Mini-MBQS-V Revised was reported to be satisfactory (ICC = .82).

As the researcher could not be blind to participants’ condition in the study, the videos were coded by the researcher at least 3 months after the study was completed with the participant.

Reliability of Mini-MBQS-V Revised. The inter-rater agreement was calculated from 24% of the total number of videos (19 out of 78). A Masters student in Child and Family

Psychology who is also an early childhood education teacher was trained by the main researcher and the two observers coded four different videos together in order to achieve an agreement in their observations. Then the student coded 19 randomly selected videos independently. The intra-class correlation coefficient and the internal consistency were satisfactory (*ICC* = .852, Cronbach's α = .867).

Parental cognitions about infant sleep. The association between infant sleep problems and parental cognitions, especially difficulty with limit setting around bedtime, has been repeatedly demonstrated in recent studies (Hall et al., 2006; Hall et al., 2017; Loutzenhiser et al., 2011; Morrell & Steele, 2003; Reader, Teti, & Cleveland, 2017; Sadeh et al., 2007; Teti & Crosby, 2012; Tikotzky & Shaashua, 2012). In accordance with the literature, The Maternal Cognitions about Infant's Sleep Questionnaire (MCISQ) was utilised in this study as well.

MCISQ was developed by Morrell (1999b) with mothers of 13 months old infants in the UK however it has been widely used in different cultures (Sadeh et al., 2007) and with both parents as well (Reader et al., 2017). The questionnaire aims to detect parents who find infant sleep problems more aversive. There are 20 items with 0 to 5 response scale where higher scores indicate more distress related to infant sleep. There are 5 subscales clustered around parents' (a) *difficulty with limit setting* at bedtime (e.g. "I should respond straightaway when my child wakes crying at night", (b) *anger* towards infant regarding the sleep difficulties (e.g. "When my child cries at night, I think I might lose control and harm him/her"), (c) *doubt* about decisions made regarding their infants sleep (e.g. "When my child does not sleep at night, I doubt my competence as a parent"), (d) worry about infants' *feeding* (hunger) at night (e.g. "If I give up feeding at night, then he/she will never sleep"), and (e) worries about infant's *safety* (e.g. "When my child cries at night, I think something awful might have happened to him/her").

Morrell (1999b) reported that the test-retest reliability after one week was r = .81 (p<.001), the Cronbach's α = .82, which is within the acceptable range. The median score of the sleep problem group was 28 and the control group was 26.5. The convergent validity was partially established through sleep diary data. There was a significant positive correlation between sleep problem scores and the limit setting, anger, and doubt subscales, but not with feeding and safety scales. The construct validity was established by comparing families with and without an infant with a sleep problem and the measure was successful in differentiating two groups. In addition, total scores were used successfully to differentiate those families who would like to receive help for their infant sleep but their infants' sleep did not meet an objective criteria for having a sleep problem. In this study, all subscales were used for analysis.

Parental Wellbeing. The Depression, Anxiety and Stress 21-item scale (DASS-21) (Lovibond & Lovibond, 1995) was implemented to screen parental wellbeing. It has previously been used as a secondary outcome measure for sleep intervention research (e.g. Gradisar et al., 2016; Price et al., 2012). It is a shorter version of the 42 item DASS to screen depression, anxiety, and stress levels of individuals. The time frame is 'over the past week' and item response scale is from 0 to 3. Raw scores are multiplied by two to obtain full scores. Higher scores indicate severity and there are four cut-off points where moderate, severe and high scores indicate the severity of the mood difficulties the individual experiences. DASS-21 was demonstrated to have a strong reliability and internal consistency in both clinical and non-clinical samples with Cronbach's alpha for depression .88-.94, for anxiety .82-.87, and for stress .90-.91 (Antony, Bieling, Cox, Enns, & Swinson, 1998). The construct validity of the measure was also established with other widely used depression, anxiety, and stress measures (Gloster et al., 2008; Henry & Crawford, 2005).

In this study, the full scores, that is, the DASS-21 scores multiplied by two, were utilised for data analysis. The psychometric data for sub-scales' mild to moderate cut-off scores were taken from Lovibond and Lovibond (1995) and the reliable change index was calculated from the alpha levels reported by Crawford and Henry (2003) as these were based on general population level scores. The alpha levels of each sub-scale was entered into the equation provided in Reliable change criterion calculator website (https://www.psyctc.org/stats/rcsc1.htm) to calculate the reliable change index (RCI) for each sub-scale. The depression sub-scale cut-off score is 13 and the RCI is ± 4.77 (rounded to 5). The Anxiety sub-scale cut-off score is nine and RCI is ± 4.79 (rounded to 5). The clinical cut off score for stress sub-scale is 18 and the RCI is ± 5.77 (rounded to 6). The RCI was displayed in the modified Brinley Plots for only the sub-scales of DASS-21.

Social validity and parent evaluation interview. There was a 30 minute evaluation interview conducted with participants at the end of the study. Their general feedback about the study and the intervention if they received it were obtained. The treatment acceptability was measured with *Treatment Evaluation Inventory-Short Form (TEI-SF)* (Kelley, Heffer, Gresham, & Elliott, 1989). This has nine items with a 5-point response scale with a total score of 45. Higher scores indicate higher satisfaction with lower stress experienced with the treatment. Scores lower than 30 indicates moderate to low satisfaction with experience of stress.

Interventions

The procedures to set up and execute interventions had three steps. In these steps, a guided participation model (Sanders & Burke, 2014) was utilised to work with families. These steps were: clinical intake interview, the setup program interview, the support through the intervention phase.

Clinical intake interview: Induction. The clinical intake interview was conducted as the second assessment in Phase-1 to gather information on the presenting problem, the history of the problem, history of infant's development from pregnancy onwards, the family background demographics, and previous and current parental wellbeing. The format of the interview was standard in the Pukemanu/Dovedale Centre and takes about an hour in total.

At the beginning of the interview, parents were further informed about the study, received information on the following steps of the intervention selection, and signed the consent form. At the end of the interview, participants received information on how to keep the sleep diary and were given the booklet. This interview was conducted with all participants however only participants who were interested in receiving an intervention attended the following steps.

The set up program interview (parent training). After conducting the first home visit and receiving at least three days of the sleep diary, a time would be negotiated with parents to meet at the clinic again, before Phase-1 ended, for a setup program interview guided from France, Henderson , and Hudson (1996). In this interview, the current state of the infant's sleep would be discussed in more detail based on information from the sleep diaries and parents' feedback. Following this, psychoeducation for the family would be conducted around the topics of infants' normative sleep development, behaviour traps that maintain sleep problems, and the evidence around effects of sleep interventions. Parents were provided with a menu of well established, evidence-based intervention options which were regularly used in the Pukemanu/Dovedale Clinic and by the researchers of Canterbury Sleep Programme (France, 2011; France & Blampied, 2005; France, Blampied, & Wilkinson, 1999; France & Hudson, 1990; Healey et al., 2009; Selim et al., 2006; Wilson, 2013).

Following this, the best time to begin the program, setting up a bedtime routine which would remain the same for the entire intervention phase, and an earliest rise time for the day were discussed. The program needed to begin when the family did not have any planned holidays or illness or house-guests and discussing an earliest rise time (usually 6 a.m.) was necessary to help parents discriminate night wakings from early rising while on the sleep program (France, 1989, 2011; France et al., 1999; France et al., 1996; France & Hudson, 1990, 1993; Healey et al., 2009). Finally, anticipated problems and solutions for these would be discussed and an action plan would be prepared. The details of the plan would be emailed to the family after the interview.

Intervention Options. The core options provided for parents were extinction with parental presence (France, 2011; Sadeh, 2005) and extinction with minimal check (France & Blampied, 2005; France et al., 1996; Healey et al., 2009). Extinction techniques are widely used methods based on the principles of operant conditioning learning theory (Blampied & Bootzin, 2013). Sleep interventions based on the principle of extinction have the main assumption that unwanted child behaviours may be maintained by parent behaviours. Removal of the reinforcing parent behaviour would change the consequence and lead to a rapid change in the problem behaviour. These techniques are usually used in conjunction with stimulus control (such as setting up a regular bedtime and bedtime routines) (Owens et al., 1999). Parents were also offered additional options such as “dream-feeding” (pre-emptively feeding a sleeping baby) and a social story book to complement the program depending on the age of the infant and feeding preferences of the family.

Modified extinction with parental presence. The main assumption of this technique is based on both social learning theory and attachment theory (France, 2011). It is assumed that infants may experience a separation anxiety from parents at night time and the cot might seem as a distressing, unfamiliar setting to fall asleep calmly (Sadeh, 1994). Therefore having the parent in the room for 1 week without intervening is suggested to decrease both parents’ and infants’ distress and helps the infant learn to fall asleep more easily (France, 2011;

Sadeh, 2005). Among families who wanted to receive a BSI, parents of Kirk, Yvonne, Hannah, Rebecca, Mike, Robyn, and Sheryl chose the parental presence.

In this technique, the parent sleeps in the same room as the child for one week. The infants' cot remains in the same place for the entire time and the technique should be done in the room that the infant will sleep in after the program. This means, the parent needs to change their evening routine for the week. The parent puts the infant in the cot and bids good night and pretends to be asleep in the extra bed where the infant can easily see them. This continues until the child falls asleep and if there is crying the parent does not intervene and just continues to feign sleep. If the infant falls asleep before the parent's preferred bed-time the parent leaves the room and returns when the infant cries again. When it is the parent's time to sleep, the parent spends the night in the infant's room without interacting with the infant if they cry or call out (France, 2011; France & Blampied, 2005).

After the first week is over and there is considerable improvement in infant's sleep, the parent returns to their own room. On the few occasions when the infant cries the parents do not attend but check the infant without being seen. (France et al., 1996). The program is suspended when there is illness or if the infant is danger (e.g. a leg through the bars of the cot) and resumed when these problems are resolved.

After four 4 weeks, provided there is major improvement and the infant consecutively sleeps through the night, parents then move on to the maintenance phase (Matthey & Črnčec, 2012; Owens et al., 1999).

Modified extinction with minimal check. This method gives the parent an opportunity to check their infant when they cry at regular intervals until the child's cry is over (Owens et al., 1999). Among families who wanted to receive a BSI, parents of Wendy, Hamish, and Robert chose to implement the minimal check program. The parent puts the child in bed after a bedtime routine, bid goodnight and leave the room. They are instructed to check their infant every 10 minutes while the infant is crying to restore the sleeping position and reassure the infant by stroking hair, speaking gently and other such actions (France et al., 1996). The parent stays in the room for no more than 2 minutes at each checking. This is a method for rapid change (Kuhn & Elliott, 2003; Matthey & Črnčec, 2012) and gives the parent reassurance by checking their infant intermittently (Owens et al., 1999). However the crying duration may take longer than it does in the parental presence technique and, as the parent attention continues, the intensity of cry may be higher (France & Blampied, 2005). The advantages and disadvantages of each technique were explained to parents and the choice was theirs to make.

Social story book. In this study SSB was used with infants whose parents judged they would be able to engage with it. This method was originally created for children with autism to improve their everyday skills such as brushing teeth. A book is created to be read to the child which includes the child's own pictures showing the child doing the target behaviour in the desired order (Gray & Garand, 1993; P. S. Moore, 2004).

The sentences and behaviour descriptions are in positive language focusing only on what the child is expected to do by simply describing the target behaviour in first person language. It is short with a maximum of 6 pages. In this study, two social story books were prepared for Mike and Robyn to be used along with the parental presence program. These focused on bedtime routines and what would happen when they wake up at night. Beginning from the first day of the selected extinction program, the parent would read the book to the child every night for one week.

Dream-feed. This technique was used as an option for parents who were not willing to withhold feeding from their infant all night. Among parents who wanted to receive a BSI, Yvonne and Robyn's mothers preferred to include one dream-feed per night during the program. After the baby settled to sleep for the first part of the night, the parent provides feeding while the infant is still asleep (Meltzer & McLaughlin Crabtree, 2015). This occurs usually around the bedtime of the parent themselves. The infant is fed quietly then gently put back in the cot. The infant is expected to fall back to sleep themselves. Other than this one feed the parents continue with providing their chosen programme throughout the night if there are any awakenings.

Support through the intervention. If parents needed any support or had concerns the researcher was available for support 24 hours a day. Outside of this, during the first week of the program participants were contacted every day and asked details of the previous night, number and duration of night wakings, and cry durations and how the parent managed the programme. Concerns were discussed when needed. During the Phase-2 home visit general feedback was received on how the program was progressing and questions or concerns were discussed in person. Intervention phase (Phase-2) would be terminated when parents and the researcher agreed the improvement goals are met.

Analyses

As described above, there were three domains of variables, namely, infant, parent and infant-parent interaction, and the data were collected at four time points. The series of analysis was divided into three levels based on the three main research questions of the study. Level 1 analyses describe the sample at Phase-1 in detail. Level 2 analyses describe the effectiveness of behavioural sleep interventions (BSI) on primary outcome variables and compares the results of the intervention group with those of the comparison infants' through time. Level 3 analyses explore changes in attachment and other secondary variables across phases, within and between participants, and as assessed at Phase-4. SPSS version 23 was used for the statistical analysis of group data. Sigma Plot version 12.5 was used for creating the time series graphs of the individual sleep data and modified Brinley Plots (MBP) to display change in the point-per phase individual data (Blampied, 2017).

Level 1. Understanding the sample. The first level of data analysis, the pre-test analysis, was conducted with the Phase-1 data. This was to describe the sample, to explore relationships among three domains of variables as well as the demographics, and to analyse differences between the two groups of families who did and did not want to implement a BSI. This was a pre-intervention (baseline), cross-sectional and between-group design. All variables in all domains, except infant sleep pattern, were included in the analysis. First, (Level 1a) a pooled sample (n = 24 participants) was analysed in order to explore the relationship between ISD, attachment, and secondary infant and parent variables. Using the larger sample by pooling all data permits a more robust analysis of relationships among variables (Tabachnick & Fidell, 2013).

1- Descriptive statistics (frequency, mean, median, and standard deviation) were used to describe the whole sample (n = 24) and the two groups of families (intervention n = 13, comparison n = 11).

2- As the sample size was small and the data were not normally distributed, nonparametric tests were employed. Cross-tabs, Chi-square test (χ^2), the Kruskal-Wallis, and Mann-Whitney U-test were used to compare the groups based on categorical attachment variables, categorical sleep variables, and characteristics of families who wanted a BSI (help-seeking/intervention) and families who did not want a BSI (non-help-seeking/comparison). A discriminant function analysis was run to generate the best model to predict the group membership using the information from continuous variables (Tabachnick & Fidell, 2013).

3- To explore possible relationships between three domains of variables, pairwise bivariate correlation and scatter plots were used. Based on the outcomes of bivariate correlations, multiple regression analysis was conducted for the continuous sleep variables and continuous attachment variables separately in order to generate the best fitting model to explain the variance in these variables. If there were no significant correlations between variables, then dependent variables with Pearson correlation coefficient (r) above .30 were included in the analysis. The three of these with highest correlations were chosen to include in the regression model.

Effect size measures. The proportion of variance accounted for (POV), which is an effect size measure for two continuous variables, were calculated by computing the effect size r^2 from Mann-Whitney U-test using the formula ($r = Z/\sqrt{N}$) (Cumming, 2013). In addition, the probability of superiority (A) was also calculated from the Mann-Whitney U-Test results. The A is a nonparametric effect size which estimates the probability that a randomly selected member of one population scores higher than a member of the other population (Ruscio, 2008; Ruscio & Mullen, 2012). It is ideal for small sample sizes because it is not sensitive to group sizes, more robust to unequal variances, and can be calculated from Mann-Whitney U-test using the following formula.

$$(A) \quad = \frac{NxNy - U}{NxNy}$$

Level 2. The effectiveness of Behavioural Sleep Interventions on primary outcome variables. The second level of data analysis comprised the analysis of idiographic sleep pattern data within single case research design principles (Kazdin, 1981). Sleep data collected in point per phase at Phases 1, 2, 3 and 4, namely, the severity of sleep problems and parental nighttime involvement, were analysed with the principles of interpreting modified Brinley Plots (Blampied, 2017). The aims were to follow change in sleep variables over time for the comparison group (n = 8) and as a function of BSI for the intervention group (n = 10), and to compare changes across individuals and across phases.

Time-series analysis. Single case research is an experimental design looking at the change in an individual's behaviour as a function of the researcher-controlled independent variable by collecting and visually analysing extensive, repeated quantitative data (Cohen et al., 2014; Cooper et al., 2007). The data are collected before (baseline), during, and after intervention and graphed on a continuous line in order to compare and examine patterns across phases by using visual analysis. In order to confidently infer that the independent variable caused the change in behaviour, baseline and intervention phases need to be replicated and similar changes should be evident (Cohen et al., 2014). Therefore, the multiple baseline across participants, which is the between-subject replication of the effect of the independent variable (i.e. BSI) was applied to three selected sleep pattern behaviours.

The number of night wakings (NW), duration of night wakings (NWDUR), and percentage (%) of target total sleep duration were presented in time series graphs for visual analysis. Each graph includes five participants from the intervention group and four participants from the comparison group sorted in ascending baseline length. The level, stability, and trend of the data were analysed by answering three questions: (1) Are the baseline data stable enough to permit interpretation? (2) Can a change be detected coincident with the intervention in Phase-2? (3) Were improvements maintained in Phase-3 and Phase-4?

Effect size measure for single case design. Each individual graph also includes the ‘Percentage Deviating from the Median’ (PEM) score for the intervention phase which is a percentage value representing the effectiveness, or the effect size, of the intervention for each child (Ma, 2006; Parker, Vannest, & Davis, 2011). PEM is utilised by calculating the median of Phase-1 data for each participant and display the median line on the graph. Depending on the targeted direction of change, the percentage of data points above or below the median line at Phase-2 were calculated (Ma, 2006). The PEM for NW and NWDUR were calculated from the data points below the Phase-1 median value at Phase-2 as these were expected to decrease as a result of intervention. The % of the target duration of total sleep achieved was expected to increase with introduction of the intervention therefore PEM was calculated from the data points exceeded the Phase-1 median value at Phase-2. Similar to general effect size measure, PEM below .7 is considered not effective, between .7 and .9 is considered moderately effective and .9 and above is considered highly effective (Ma, 2009). Details of the graphs are described in the Results chapter.

The Modified Brinley Plots (MBP). MBP are employed in single case research with multiple participants and comparison groups to detect systematic effects of interventions by observing individuals' data on a scatter plot of baseline versus intervention and follow up phases (Blampied, 2017). As MBP also allows the combination of statistical analysis of group comparison with idiographic design, it has been increasingly used in the intervention research (Gordon, Rucklidge, Blampied, & Johnstone, 2015; Lothian, Blampied, & Rucklidge, 2016; Rucklidge & Blampied, 2011). The modified Brinley Plots (MBP) were generated to display the direction, extent, and consistency of change in individuals and across individuals' point-per-phase data in each phase relative to Phase-1 data (Blampied, 2017).

The severity of sleep problem scores and the parental nighttime involvement, in both groups were plotted for each participant over pairs of Phase-1 (on the x-axis) to Phases 2, 3, and 4 (on the y-axis). Modified Brinley Plots (Blampied, 2017) require that the x-axis and y-axis scales are the same for each plot. The diagonal line at 45^0 marks the 'line of no change' (X = Y). Points above this line indicate increased effect and points below this line indicate decreased effect relative to Baseline (x-axis). Pre- and post- cut-off scores are shown as vertical (pre) and horizontal (post) lines when this information was available for a variable. The data are interpreted by examining the clustering or dispersion of data points in the graph space relative to the 45^0 and the cut-off lines (see Figure 3 for an example). Group means were calculated for each phase and are plotted as a **+** sign to indicate the coordinates of the respective means. Given that the baseline mean is fixed on the x-axis, change in the location of the mean value from the 'line of no change' indicates a detectable increase or decrease in the mean relative to Phase 1.

As the sample size was small and the data were not normally distributed, nonparametric tests were employed and results were reported along with the visual analyses of the MBPs. The Wilcoxon Rank Sum Test for repeated measures was conducted to compare within-group changes in scores from Phase-1 to Phase-4. The Mann-Whitney *U*-test for independent samples was conducted to compare the Phase-4 scores of intervention and comparison groups.

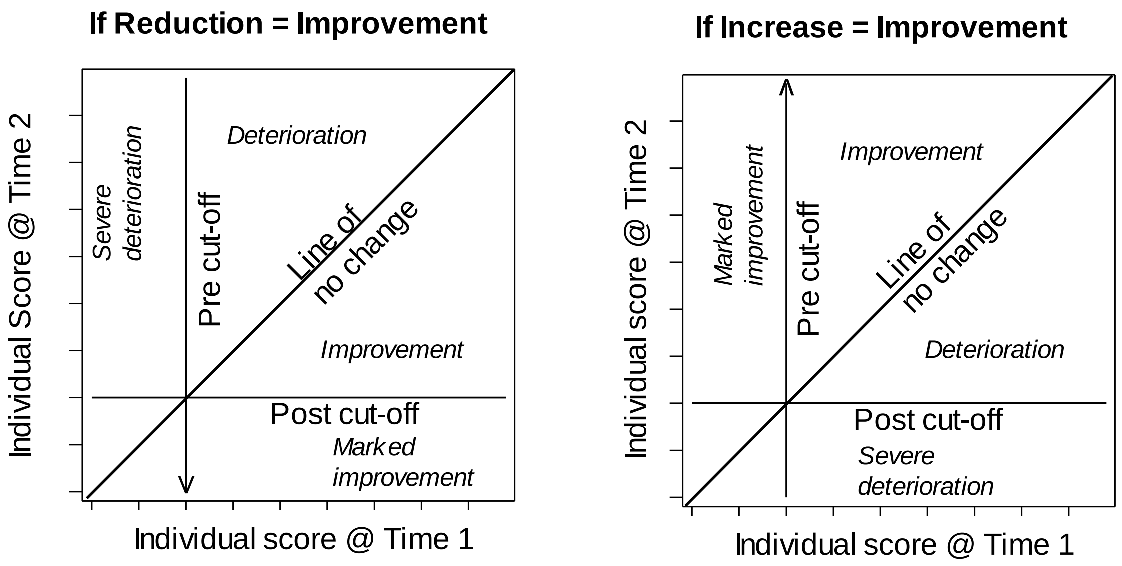

Figure 3. An example modified Brinley Plot with the cut-off scores shown as vertical and horizontal lines, dividing the plot into zones of change.

Level 3. The analysis of change in attachment and secondary variables within and across participants through 4 phases. The secondary outcome data collected in point per phase which were detected to be associated with sleep and attachment variables at Level 1 analysis was also analysed with the principles of interpreting modified Brinley Plots (Blampied, 2017). All MBP's except attachment security and cry duration at SSP separation episodes used individual baseline scores as the reference (x-axis), against which were plotted pairwise the same individual's data for Phase-2, Phase-3, and Phase-4 (y-axis). The additional statistical analyses used are as described above.

In addition, the reliable change index (RCI) (Jacobson & Truax, 1991) is shown for the DASS-21 MBPs (see Figure 4 for an example). The RCI is based on the Standard Error of Measurement (SE_M) for each subscale of DASS-21 (see above for the calculation steps). Only the DASS-21 RCI could be calculated because only for this measure was the requisite psychometric information available. The dashed lines below and above the 45^0 line indicate the RCI boundaries. Data points outside (i.e., below or above) these dashed lines indicate a reliable change, i.e., a change larger than that likely due to measurement error alone.

Attachment security scores and cry duration at SSP separation episodes were plotted as Baseline versus Phase-4 since measures were taken for these variables only at those time points. Intervention and comparison participants' data are displayed in side-by-side plots for each DV. In addition, using the data from Phase-1 and Phase-4, the attachment variables at Phase-1 (n = 18) and Phase-4 (n = 17) were analysed historically and concurrently to detect whether they were predictive of and influenced by the change in the severity of sleep problems scores from Phase-1 to Phase-4 (*Change score* = (*Richman's CSS at Phase-1*) - (*Richman's CSS at Phase-4*)) and parental nighttime involvement at Phase-4 by calculating the point-biserial correlations.

Effect size measure for a categorical variable. The point-biserial correlation (r_{pb}) is a type of effect size measure which is about the variance in one continuous variable explained or predicted by a dichotomous variable. The r_{pb} lies between .79 to +.79 and .10 indicates small, .24 indicates moderate, and .37 indicates a large effect size (P. D. Ellis, 2010). It was calculated by using the pairwise bivariate correlation analysis in the SPSS by entering the dichotomous attachment security as the dummy variable.

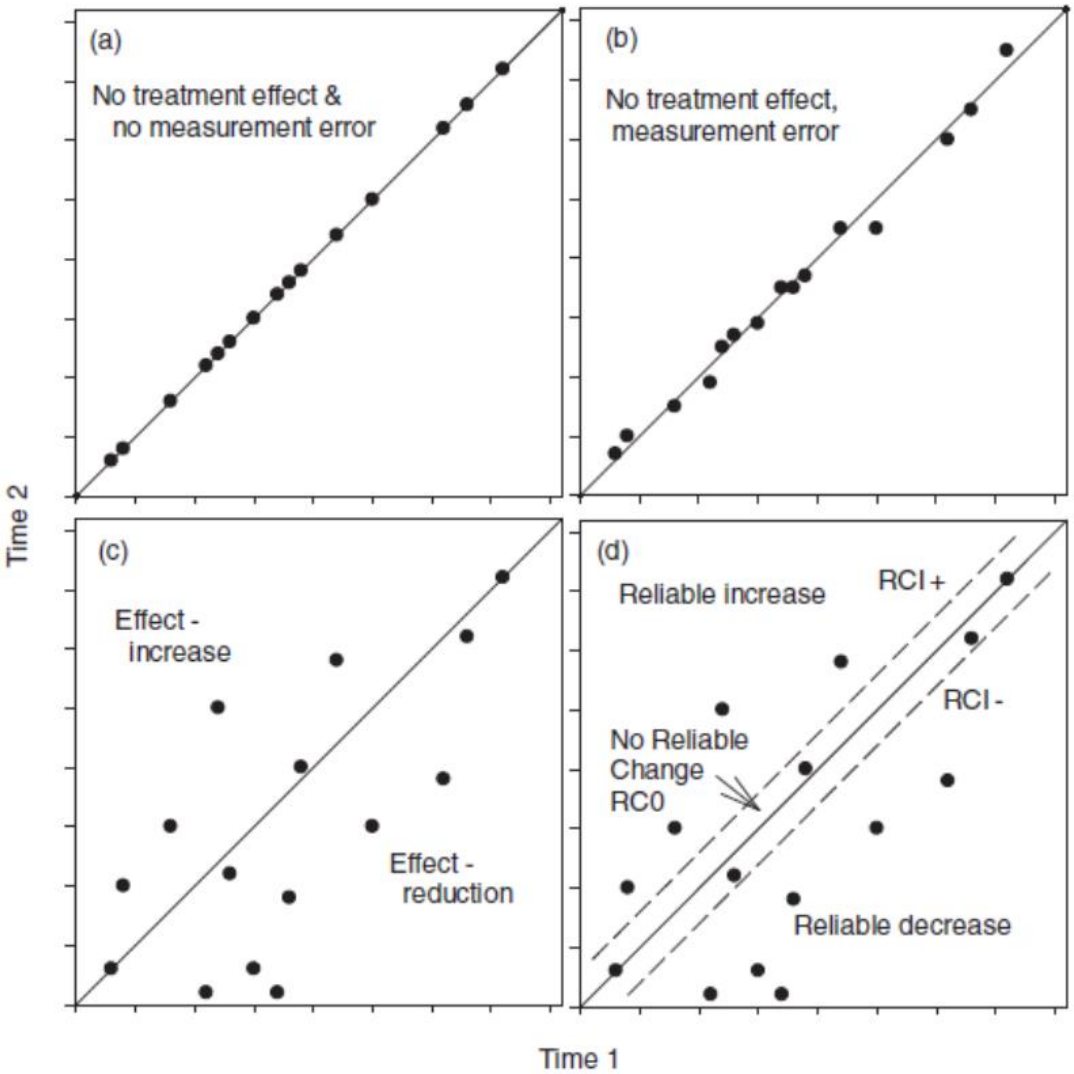

Figure 4. The basic features of a modified Brinley Plot with Reliable Change Index dashed lines.

Note. Each data point represents a participant's Time-1 versus Time-2 scores. (RC+) = reliable increase, (RC-) = reliable decrease, (RC0) = no reliable change. Reprinted from "Analyzing therapeutic change using Modified Brinley Plots: History, construction, and interpretation" by N. M. Blampied, 2017, *Behavior Therapy, 48*, p.117. Copyright 2016 Association for Behavioral and Cognitive Therapies. Reprinted with permission.

Results

Results are presented in the order of the research questions as outlined in three levels and steps of data analysis are described in detail under the Analysis section of the Method chapter.

Level 1a. Understanding the Sample (*n* =24)

The first level of analysis looked at cross-sectional Phase-1 data and included both categorical and continuous data collected at Phase-1 and constituted all variables recorded except for sleep patterns. The first level of analysis has two components: the larger sample (*n* =24) who completed the Phase-1 assessments (referred to as Level 1a) and the smaller sample (*n* =18) who continued the study after Phase-1 assessments and completed all phases (Level 1b). Results of Level 1b are provided in Appendix I as it duplicates the steps followed in Level 1a. Thus, a summary of Level 1b results are provided at the end of the Level 1 section.

At Level 1, descriptive and exploratory analyses are presented separately. Descriptive analysis covered all categorical data as frequencies and between-group comparisons were conducted using standard Chi-Square (χ^2) tests. All continuous data were compared for groups based on the categorical attachment and sleep variables (for example, secure vs insecure attachment, or, having ISD since birth or not), and parents' help-seeking preferences, i.e., help-seeking (referred to below as 'intervention') vs non-help-seeking (referred to as 'comparison') groups. Group medians were compared using non-parametric statistics, namely, the Kruskal-Wallis and Mann-Whitney *U*-Tests. Discriminant Function Analysis (DFA) was used to predict membership of the intervention vs comparison groups, using continuous independent variables.

Exploratory analysis examined pairwise bivariate correlations of within-sleep variables, within-attachment variables, and between attachment, sleep, and parent-infant secondary variables. Standard multiple regression analysis then followed to identify variables predicting selected sleep and attachment variables. The minimum alpha level was $p < .05$, two tailed, for statistical significance.

Descriptive analysis (*n* = 24).

Categorical attachment variables. The categorical attachment variables, as displayed in Figure 2 in the Methods section, were the normative attachment patterns, namely, insecure-avoidant (A), secure (B), and insecure-ambivalent/resistant (C), and the binary categorisations of infants with secure/insecure and B4/non-B4 attachments. The distributions were as follows.

The distribution of normative attachment patterns. Seventeen infants (71%) were classified as B, three infants were classified as A (12%), and four infants (17%) were classified as having a C pattern (see Figure 5 and Table 10). Seven infants out of 17 (41%) with B attachment were classified into the B4 sub-category.

The binary attachment variables. The sample was further divided into secure (n = 17, 71%) and insecure (n = 7, 29%); B4 (n =7, 29%) versus non-B4 (n = 17, 71%) attachment groups and the sample characteristics were compared.

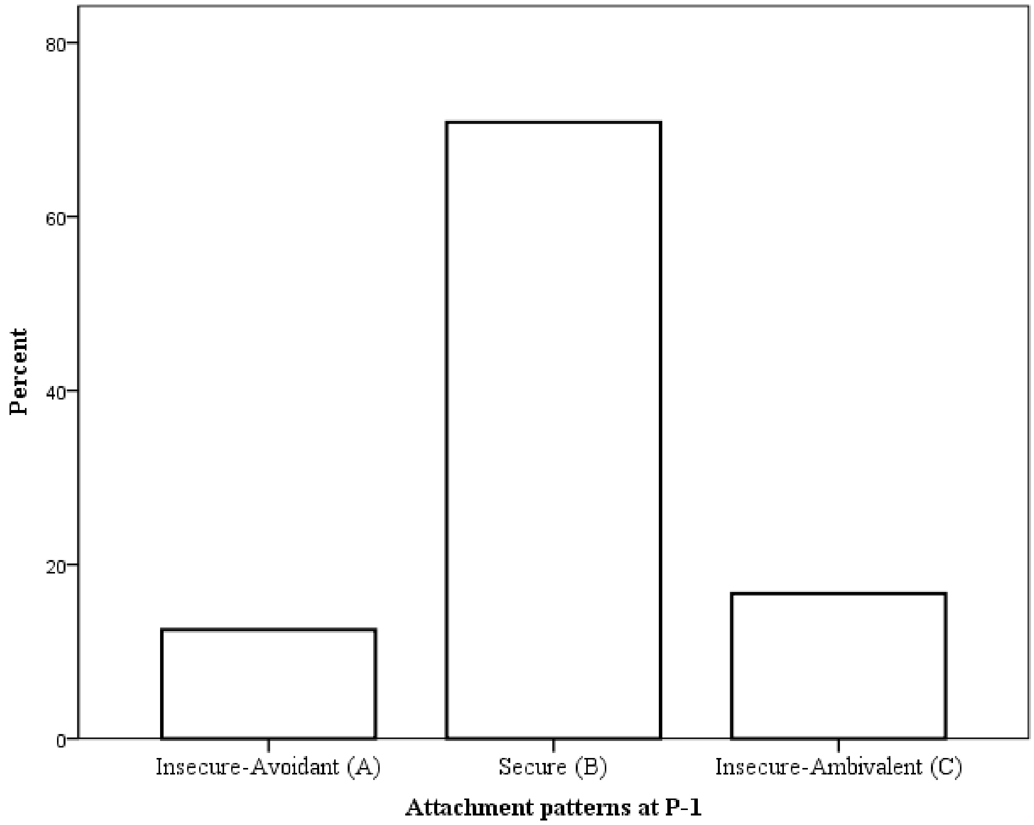

Figure 5. The distribution of normative attachment patterns in ABC coding with *n* = 24.
Note. P-1 = Phase-1.

Categorical sleep characteristics.

Current sleep, history, and location of sleep. Frequencies and percentages are provided in Table 10. Sixteen infants (67%) were reported to have sleep disturbance since birth. Twenty one mothers (88%) breastfed their infants at nighttime. While only four infants were sleeping in their own cot for the whole night at the time of the study, 21% (*n* = 5) of parents practiced intentional cosleeping and 63% of parents (*n* = 15) practiced reactive cosleeping. Fourteen families (58%) reported unsuccessfully trying some sort of behavioural sleep intervention in the past either self-initiated or with the help of a professional.

Table 10. *Attachment and sleep characteristics of participants in intervention and comparison groups at Phase-1(n = 24)*

	Phase-1 (n = 24)						
	Intervention		Comparison		Total		
Variables	n = 13		n = 11		n = 24		
Attachment[1]	n	%	n	%	n	%	X^2
A	2	15	1	9	3	12	
B	9	70	8	73	17	71	
C	2	15	2	18	4	17	
							.227
Sleep characteristics							
ISD since birth	7	54	9	82	16	67	2.098
Breastfeed at night	12	92	9	82	21	88	.599
Intentional cosleeping	0	0	5	46	5	21	**7.552***
Reactive cosleeping	10	77	5	46	15	63	**7.464***
Tried BSIs before	10	77	4	36	14	58	**4.033***

Note. [1] The distribution of normative attachment patterns. A = Avoidant attachment pattern, B =Secure attachment pattern, BSI = Behavioural Sleep intervention, C = Ambivalent/Resistant attachment pattern, ISD = Infant Sleep Disturbance, *p < .05.

Continuous attachment variables. A summary of means, standard deviations, medians, and *p* values of all continuous variables from intervention and comparison families are provided in Table 11.

Attachment resistance. The observed range of the total resistance scores from SSP episodes 5 and 8 was 2 to 10 (possible range 2 – 14). The mean = 4.38, *SD* = 2.46, and the median = 3.50. The distribution was negatively skewed.

Attachment Security. The scores ranged from -6.19 to 4.78. The mean = 1.33, *SD* = 2.84, and the median = 2.36. The distribution was strongly positively skewed.

Continuous sleep variables.

The Severity of sleep problems. The Richman Composite Sleep Scores (CSS) for 24 participants ranged from 9 to 20 (possible range 0 – 24) with the mean = 13.75, *SD* = 3.04, and median = 13.50. According to the cut-off points, all infants had ISD and 75% (*n* = 18) had severe ISD.

Parental nighttime involvement. The average intensity of parent involvement at nighttime as measured with the Bedtime Soothing Scale (BSS) was calculated from the same 7 days the CSS was calculated from. The average BSS scores ranged from 3 to 5 (possible range 1 to 5). The mean = 4.4, *SD* = .74, and the median = 4.8. Thus, all parents were highly involved with the infant while the infant was falling asleep.

Table 11. *Means, standard deviations, medians, and p values of attachment, sleep, infant and parent secondary variables of total sample (n=24), intervention (n=13), and comparison (n=11) groups*

	Total (*n* = 24)		Intervention (*n* = 13)		Comparison (*n* = 11)		
Variables	*M (SD)*	*Mdn*	*M (SD)*	*Mdn*	*M (SD)*	*Mdn*	*U*[1]
Attachment							
Resistance	4.3 (2.4)	3.5	4.15 (2.1)	4	4.64 (2.8)	3	67.0
Security	1.3 (2.8)	2.3	1.38 (2.4)	1.7	1.25 (3.4)	2.8	66.5
Sleep							
The severity of sleep problems	13.7 (3.0)	13.5	12.7 (2.8)	13	14.9 (3.0)	14	44.0
Parental nighttime involvement	4.4 (.73)	4.7	4.1 (.86)	4.5	4.7 (.40)	5	45.5
Infant negative emotionality							
Perceived NE (ICQ)	15.7 (4.8)	16	14.2 (4.3)	13	17.6 (4.8)	19	42.0
Frequency of observed NE	3.5 (3.6)	2	3.7 (4.0)	2	3.27 (3.2)	2	68.0
NE Scale	1.5 (1.0)	1	1.7 (1.0)	1	1.3 (.90)	1	86.0
Cry duration at SSP separation episodes	20.5 (13.0)	21.5	15.5 (11.8)	13	26.4 (12.3)	34	**32.0***
Parental daytime sensitivity	.48 (.32)	.58	.58 (.27)	.64	.36 (.35)	.45	97.0
Parental cognitions about infant sleep (MCISQ)							
Limit Setting	17.5 (4.5)	18	15.3 (4.4)	16	20.0 (3.1)	21	**25.0****
Doubt	8.5 (4.6)	7.5	7.8 (4.3)	7	9.4 (5.0)	8	58.5
Anger	6.8 (3.3)	7.5	7.3 (3.2)	7	6.3 (3.6)	8	78.5
Feeding	7.5 (2.9)	8.5	7.3 (2.9)	9	7.7 (3.0)	8	66.5
Safety	3.5 (2.5)	3	3.5 (2.9)	3	3.5 (2.0)	3	66.5
Total	44.0 (10.8)	41	41.3 (11.7)	38	47.1 (9.3)	48	48.5
Parental wellbeing (DASS-21)							
Depression	5.0 (6.1)	2	4.6 (6.7)	2	5.6 (5.6)	6	60.0
Anxiety	4.40 (5.2)	2	4 (5.8)	2	4.9 (4.5)	4	55.0
Stress	11.5 (7.90)	8	10.7 (8.3)	8	12.5 (7.6)	8	62.0
Total	21.0 (17.2)	14	19.3 (19.1)	12	23.0 (15.3)	24	57.0

Notes. [1] Mann-Whitney U-Test, DASS-21= 21-item Depression, Anxiety, Stress Scale, ICQ = Infant Characteristics Questionnaire, MCISQ = Maternal Cognitions about Infant Sleep Questionnaires, NE = Negative Emotionality.
*p = 0.022 < .05, **p = 0.007 < .01.

Group comparisons for attachment categorical variables. Groups formed according to the A, B, and C infant attachment patterns were compared using the independent samples Kruskal-Wallis test for the median severity of sleep problems, infant negative emotionality, parental nighttime involvement, parental daytime sensitivity, cognitions about infant sleep, and wellbeing. There were no statistically significant differences between groups on these variables.

Similarly, secure/insecure and B4/Non-B4 attachment groups were compared for the median severity of sleep problems, infant negative emotionality, parental nighttime involvement, parental daytime sensitivity, cognitions about infant sleep, and wellbeing using the independent samples Mann-Whitney *U*-Test. Results indicated that the median parental daytime sensitivity scores were higher for parents of secure infants (*Mdn* = .65) than parents of insecure infants (*Mdn* = .22), *U* = 96.0, *p* = .019. Infants with B4 attachment sub-category cried for longer durations at SSP separation episodes *(Mdn* = 34) than infants with other attachment categories *(Mdn* = 15), *U* = 108.5, *p* = .001.

Group comparisons for sleep categorical variables. The sample (*n* = 24) was divided into two groups based on the time of onset of ISD (Birth *n* = 16 vs later, primary or secondary, ISD *n* = 8), cosleeping (intentional, *n* = 5 vs reactive, *n* = 10), and previous BSI attempts (no attempts, *n* = 10, vs at least one attempt, *n* =14). These groups were compared for the severity of sleep problems, attachment security and resistance, infant negative emotionality, parental nighttime involvement, parental daytime sensitivity, cognitions about infant sleep, and wellbeing, using the independent samples Mann-Whitney *U*-Test.

Results indicated that the severity of sleep problems was greater for infants with ISD since birth (*Mdn* = 15.5) than infants who developed ISD later (*Mdn* = 11.5), *U* = 22, *p* = .009. In addition, parental nighttime involvement was higher for infants with ISD since birth (*Mdn* = 5) than infants who developed ISD later (*Mdn* = 3.75), *U* = 30.5, *p* = .038.

In order to compare families in intentional (*n* = 5) and reactive cosleeping (*n* = 15) groups, infants who only slept in their cot (*n* = 4) were omitted from the analysis. Results indicated that the severity of sleep problems was greater for participants in the intentional cosleeping group (*Mdn* = 18) than participants in reactive cosleeping group (*Mdn* = 14), *U* = 14, *p* = .042.

Families were also compared for their previous BSI attempts by separating the sample into those who had tried BSIs at least once (*n* = 14) and those who had not (*n* = 10). Results indicated that parents who had tried an intervention at least once scored higher on Anger subscale of MCISQ (*Mdn* = 8.50) than parents who had not used an intervention (*Mdn* = 5), *U* = 103.5, *p* =.048.

Comparison of intervention (help-seeking) and comparison (non-help-seeking) families. Cross tabs were computed to compare demographics, categorical attachment variables, current sleep, history, and location of sleep data for families who wanted to receive a BSI (intervention group, *n* =13, infants' mean age in months = 13.19, *SD* = 1.5) and those who did not (comparison group, *n* = 11, infants' mean age in months = 13.12, *SD* = 1.14) using χ^2 test (Table 10).

The median severity of sleep problems, attachment security, disorganisation, and resistance, infant negative emotionality, parental nighttime involvement, parental daytime sensitivity, cognitions about infant sleep, and wellbeing of the intervention and comparison groups were compared using the independent samples Mann-Whitney *U*-Test (Table 11). Results were as follows.

Demographics. There were no differences in the distribution of child gender, mothers' and fathers' working status, infant day-care attendance, parity of the infant, SES level, ethnicity, and parents' relationship status between groups.

Attachment variables. There were no between-group differences in the distribution of secure/insecure, B4/nonB4, and ABC attachment groups. The two groups were very similar in terms of their attachment distributions (see Table 10).

Current sleep, history, and location of sleep. Groups did not differ in frequency of breastfeeding at nighttime, and the timing of onset of ISD. The two groups were different in the sleep location of their infant and their previous BSI attempts. While parents in the intervention group tended to prefer intentional cosleeping, parents in the comparison group tended to practice reactive cosleeping ($\chi^2 = 7.552$, $p = .023$). More parents in the intervention group reported previous attempts with BSIs than parents in the comparison group (χ^2-linear association = 4.967, $p = .026$).

Continuous variables. The two groups' medians were not significantly different for severity of sleep problems, perceived negative emotionality, observed negative emotionality at free-play of infants, parental nighttime involvement and wellbeing. But the two groups were observed to have different median infant cry durations at SSP separation episodes and difficulty with the limit setting subscale of MCISQ (see Table 11).

Results indicated that cry duration at SSP separation episodes for infants in the comparison group (*Mdn* = 34) was longer than for infants in the intervention group (*Mdn* = 13, $U = 32$, $p = .022$, $A = .77$). Difficulty with limit setting for parents in the comparison group (*Mdn* = 21) was higher than for parents in the intervention group (*Mdn* = 16, $U = 25$, $p = .006$, $A = .82$). The proportion of variance accounted for (POV) were calculated by computing r from Mann-Whitney U-test using the formula ($r = Z/\sqrt{N}$). The POV (effect size r^2) explained by group membership was 22% ($r = -.469$) for cry duration and 30% ($r = -.552$) for limit setting.

Identifying Predictors of help-seeking group membership using Discriminant Function Analysis. Two-group step-wise discriminant function analysis was used to further analyse whether any of the independent continuous variables could successfully predict membership for the two groups designated by help-seeking preferences.

Among all continuous variables, infants' cry duration at SSP separation episodes and parents' difficulty with limit setting at bedtime MCISQ scores, were identified as significant contributors to the prediction model. The overall Chi-square test was significant (Wilks λ = .597, χ^2 = 10.826, df = 2, R^2-canonical = .635, p <. 01) and the model accounted for 40% of the between group variance. The model generated with these two variables correctly classified 9/11 of the non-help seeking group and 12/13 of the intervention group with overall accuracy of 87.5%. Both the difficulty with limit setting at bedtime (the standardised R^2-canonical = .823, structure weight = .771) and the cry duration at SSP separation episodes (the standardised R^2-canonical = .639, structure weight = .572) contributed to the multivariate effect.

Exploratory analysis (*n* = 24).

Correlations of within- attachment variables at Phase-1. As Figure 6 shows, attachment security scores significantly correlated with attachment resistance (r = -.628, p<.01) in negative direction and the R^2 = .394.

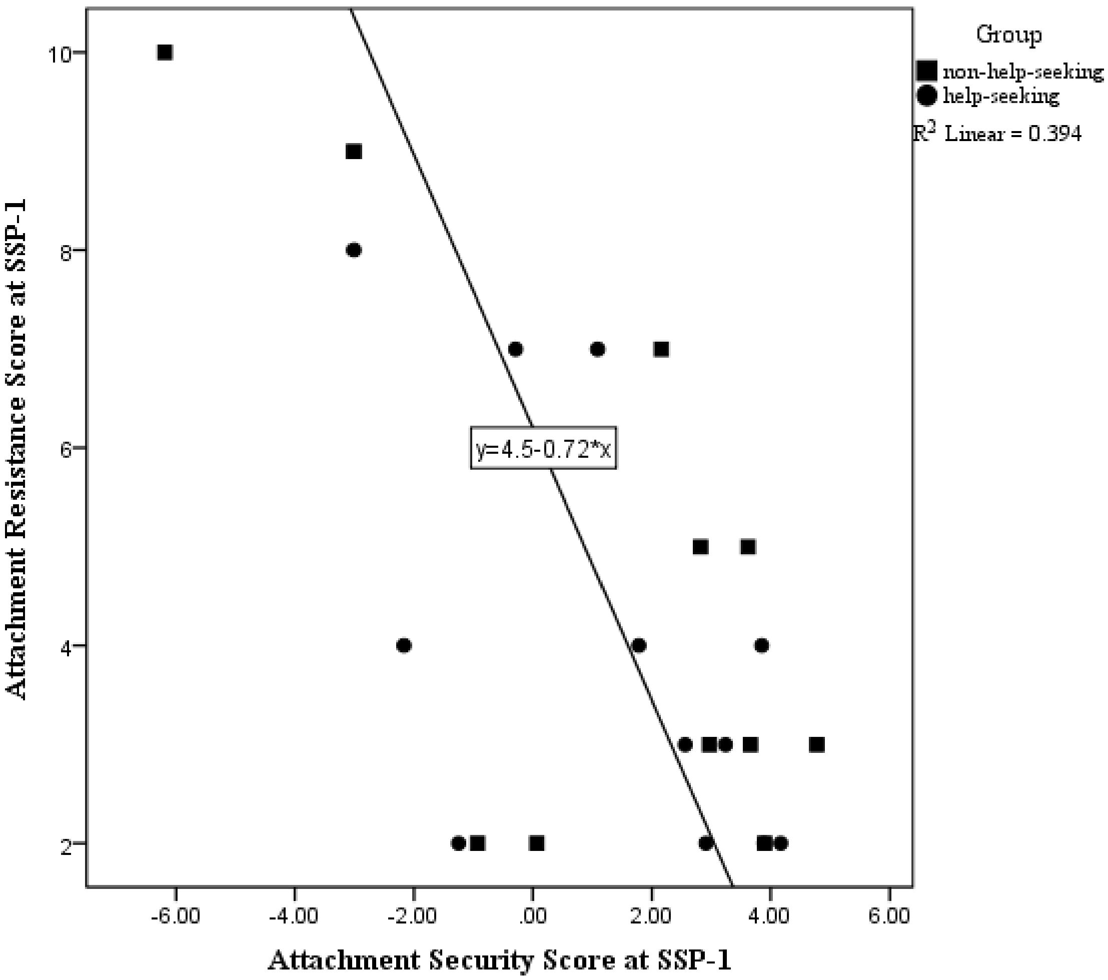

Figure 6. Scatterplot and linear regression line of the relationship between the attachment security score as measured by the modified Richters' Formula and attachment resistance score from the interactive attachment behaviour scale at Phase-1 (n = 24).

Note. Participants in intervention (n =13) group was indicated with circle and participants in comparison (n = 11) group was indicated with rectangle.

Correlations of within-sleep variables at Phase-1. There was a positive linear relationship between the severity of sleep problems and parental nighttime involvement (Pearson r = .578, p = .003) and the R^2 = .334 as demonstrated in the scatterplot in Figure 7.

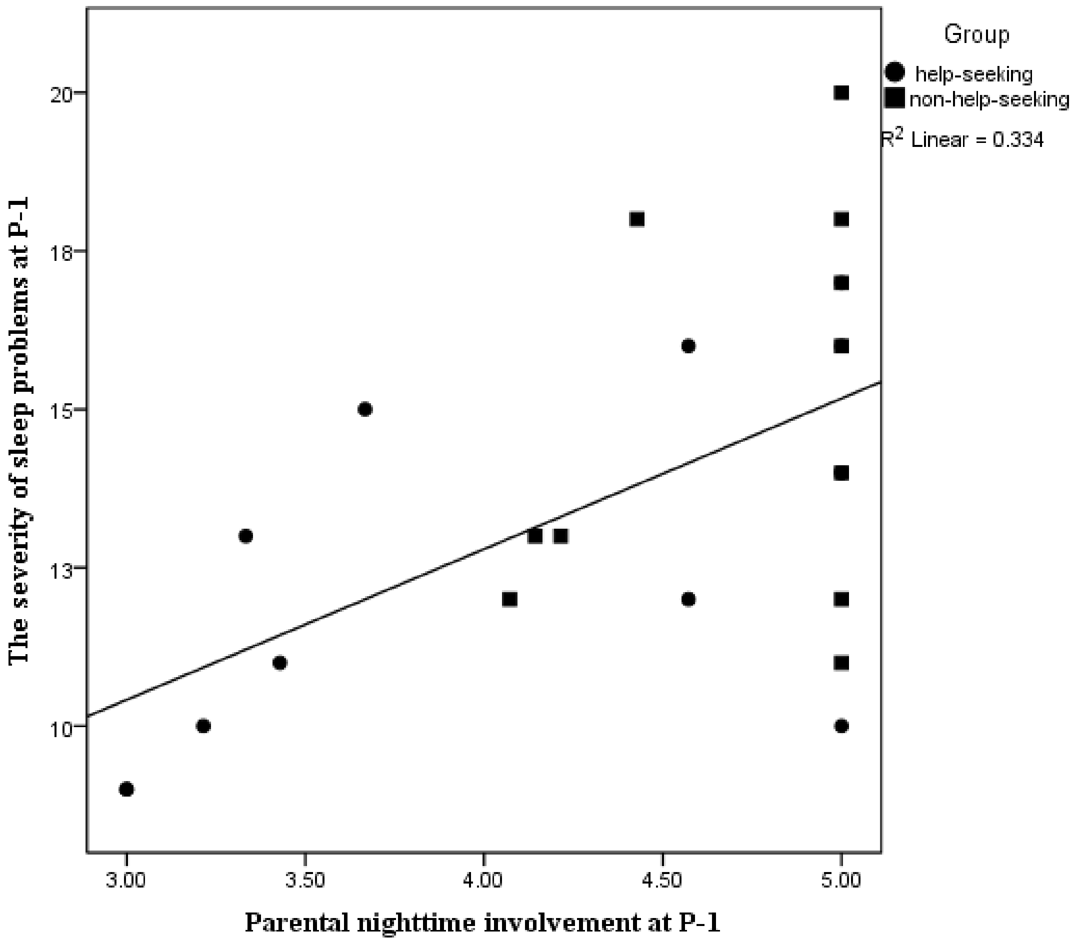

Figure 7. Scatterplot and linear regression line of the relationship between the severity of sleep problems and the parental nighttime involvement at Phase-1 (n = 24).

Note. Participants in intervention (n =13) group was indicated with circle and participants in comparison (n = 11) groups was indicated with rectangle.

Associations between attachment and sleep variables at Phase-1. Pairwise bivariate correlations were also computed for the severity of sleep problems, parental nighttime involvement, attachment security, and attachment resistance scores. No correlation was > -.07, indicating no meaningful correlations between these variables (see Table 12).

Table 12. *Pearson correlation coefficients for sleep and attachment variables at Phase-1 (n = 24)*

Variables	Attachment security	Attachment Resistance
The severity of sleep problems	.053	-.057
Parental nighttime involvement	-.072	.063

Secondary variable associations.

Infant negative emotionality, attachment and sleep variables. As shown in Table 13, there were no significant relationships between infant negative emotionality measures and any attachment variables. Associations between the severity of sleep problems and frequency of observed NE (r = -.318) and the NE scale (r = -.372) were not statistically significant however these were in negative direction. Parental involvement at nighttime and cry duration at SSP episodes (r = .329) were also not statistically significant and none were larger than ±.37.

Table 13. *Pearson correlation coefficients matrix for infant negative emotionality, attachment and sleep variables at Phase-1 (n=24)*

Variables	1	2	3	4	5	6	7	8
8. Cry Duration at SSP Separation Episodes	.235	.380	.247	.329	.171	.131	.044	—
7. NE Scale	.283	-.004	-.372	-.288	-.133	**.910****	—	
6. Frequency of Observed NE	.166	.098	-.318	-.117	-.023	—		
5. Perceived NE	-.044	.160	-.042	-.183	—			
4. Parental nighttime involvement	—	—	—	—				
3. The severity of sleep problems	—	—	—					
2. Attachment resistance	—	—						
1. Attachment security	—							

Note. $^{**}p$<.01

Parental daytime sensitivity, cognitions about infant sleep, attachment and sleep variables. As Table 14 shows, there were no statistically significant correlations between parental cognitions, attachment security, parental daytime sensitivity and attachment resistance nor were there any statistically significant correlations between Parental Daytime Sensitivity and any aspects of Parental Cognitions. There was a moderate but not significant positive association between the severity of sleep problems and MCISQ Limit setting (r = .365) and Feeding (r = .396) subscales. There were no significant correlations between parental daytime sensitivity and sleep variables.

Table 14. *Pearson correlation coefficients matrix for parental daytime sensitivity, cognitions about infant sleep, attachment and sleep variables at Phase-1 (n=24)*

Variables	1	2	3	4	5	6	7	8	9	10	11
11. MCISQ Total	.077	-.061	.315	-.038	-.223	**.639****	**.793****	.352	**.609****	**.525****	—
10. MCISQ Safety	.112	.127	-.180	-.084	-.282	.154	**.591****	-.216	.164	—	
9. MCISQ Feeding	-.028	.205	.396	.104	-.056	.340	.349	.033	—		
8. MCISQ Anger	.040	-.379	.052	-.064	.050	.027	.165	—			
7. MCISQ Doubt	.165	-.062	.192	-.183	-.307	.201	—				
6. MCISQ Limit Setting	-.056	-.002	.365	.123	-.067	—					
5. Parental Daytime Sensitivity	.312	-.062	.028	-.145	—						
4. Parental nighttime involvement				—							
3. The severity of sleep problems			—								
2. Attachment Resistance		—									
1. Attachment Security	—										

Note. MCISQ = Maternal cognitions about infant sleep questionnaire. $^{**}p$<.01.

Parental wellbeing, attachment and sleep variables. There were no substantive correlations between DASS-21 depression, anxiety, stress, and total scores and any of the attachment variables (see Table 15) although, as expected, the DASS-21 scores were highly inter-correlated. None of the DASS-21 scores correlated significantly with Parental daytime sensitivity either. Correlations between the severity of sleep problems and DASS-21 scores of parents were very small. However, the parental involvement at nighttime was moderately, but not significantly, correlated with overall wellbeing (r = -.398), depression (r = -.336), anxiety (r = -.401) and stress (r = -.342) scores of parents in the negative direction. Parental daytime sensitivity was not significantly correlated with sleep variables and DASS-21 scores.

Table 15. *Pearson correlation coefficients matrix for parental wellbeing, parental daytime sensitivity, sleep and attachment variables at Phase-1 (n=24)*

Variables	1	2	3	4	5	6	7	8	9
9. DASS21 Total	-.040	-.102	-.178	-.398	-.097	**.849****	**.917****	**.916****	—
8. DASS21 Stress	.035	-.036	-.062	-.342	.013	**.609****	**.793****	—	
7. DASS21 Anxiety	-.007	-.120	-.244	-.401	-.050	**.702****	—		
6. DASS21 Depression	-.152	-.137	-.213	-.336	-.248	—			
5. Parental Daytime Sensitivity	.312	-.062	.028	-.145	—				
4. Parental nighttime involvement				—					
3. The severity of sleep problems			—						
2. Attachment Resistance		—							
1. Attachment Security	—								

Note. DASS-21 = Depression, Anxiety, and Stress Scale 21-item version. $^{**}p$<.01.

Predictors of attachment and sleep variables.

Attachment variables. There were not enough variables significantly related to the attachment variables to run a regression analysis examining the predictors of attachment.

The severity of sleep problems. A standard multiple linear regression was calculated to develop a model for predicting the severity of sleep problems measured by the Richman's composite sleep score (CSS) using the infant and parent variables (*n* = 24).

First, variables that correlated with the severity of sleep problems significantly or at *r*>.30 were identified. Among these variables, those which had the highest correlations with the severity of sleep problems and that were not significantly correlated with each other were selected for inclusion in the analysis. These predictor variables were parental nighttime involvement (mean = 4.40, *SD*=.73), MCISQ Feeding subscale (mean = 7.54, *SD* = 2.9), NE Scale (mean = 1.58, *SD* = 1.0), and MCISQ Limit Setting subscale (mean = 17.50, SD = 4.5).

The predicted variable (the severity of sleep problems) was the Richman's CSS. Preliminary analyses were performed to detect multicollinearity, normality, linearity, and outliers to ensure there was no violation of the assumption of normality.

A significant regression equation was found (F (4, 19) = 6.969, p = .001) with an R^2 of .595 and with an adjusted R^2 of .509. Standard error of the estimate was 2.129. Parental involvement at nighttime (β = .409, p<.05, 95% CI [.340-3.029]), MCISQ Feeding subscale (β = .385, p <.05, 95% CI [.044-.754]), and NE scale (β = -.363, p <.05, 95% CI [-2.089- -.080]) made a unique contribution to the prediction of the model. High parental involvement at nighttime had the largest contribution explaining 14% of the variance. The feeding subscale of MCISQ, which is related to worries about infants' hunger at night, explained 11% of the variance, and having lower scores on NE Scale explained 10% of the variance (See Table 16).

Table 16. *Summary of standard multiple linear regression analysis for variables predicting the severity of sleep problems at Phase-1 (n=24)*

	The severity of sleep problems				
Variable	*B*	*SE B*	*β*	*t*	*P*
Parental nighttime involvement	1.685	.642	.409	2.622	**.017***
MCISQ Feeding	.399	.170	.385	2.353	**.030***
NE Scale	-1.084	.480	-.363	-2.259	**.036***
MCISQ Limit Setting	.129	.104	.193	1.238	.231
R^2(adj. R^2)		.595 (.509)			
F		6.969			**.001****

Note: * p<.05, **p<.01

Parental nighttime involvement. A second standard multiple linear regression was employed to examine predictors of parental nighttime involvement as measured by the averaged CSS week scores of the Bedtime Soothing Scale (BSS) using the infant and parent variables. The same selection procedure as described above was followed. Variables which had the highest correlations with parental nighttime involvement and that were not significantly correlated with each other were selected as predictor variables, with parental nighttime involvement as the predicted variable.

The predictor variables were the severity of sleep problems (mean = 13.75, *SD* = 3.04), Cry duration at SSP separation episodes (mean = 20.54, *SD* = 13.0), and DASS-21 Total score (mean = 21.08, *SD* = 17.27). Preliminary analyses were performed on multicollinearity, normality, linearity, and outliers to ensure there was no violation of the assumption of normality. A significant regression equation was found (F (3, 20) = 5.197, p = .008) with an R^2 of .438 and with an adjusted R^2 of .354. Standard error of the estimate was

.593. Among these predictor variables, only the severity of sleep problems made a significant contribution to the model (β = .497, p<.05, 95% CI [.033-.209]) and explained 22% of the variance (See Table 17).

Table 17. *Summary of standard multiple linear regression analysis for variables predicting parental nighttime involvement at Phase-1 (n=24)*

Variable	Parental nighttime involvement				
	B	*SE B*	β	*t*	*P*
The severity of sleep problem	.121	.042	.497	2.857	**.010***
Cry duration at SSP Separation Episodes	.007	.010	.128	.718	.481
DASS-21 Total	-.012	.008	-.272	-1.546	.138
$R^2 (adj. R^2)$		.438 (.354)			
F		5.197			**.008****

Note: * p<.05, **p<.01

Summary of Level 1a Findings (*n* = 24). In this sample, the normative distribution of attachment patterns were 71% secure (29% B4), 12% avoidant and 17% ambivalent. All infants had ISD based on the Richman's criteria and 75% had severe ISD with scores above 12. Infants with ISD since birth had more severe sleep problem scores than other infants and their parents were more involved at nighttime. Severity of sleep problems was greater for families who practiced intentional cosleeping than parents who practiced reactive cosleeping. Parents who tried BSIs at least once scored higher on the Anger subscale of MCISQ. All parents were highly involved with their infant at bedtime and nighttime as they were actively soothing their babies to sleep. Twenty participants were cosleeping with their baby however only five parents practiced intentional cosleeping and they were all in the comparison group. However, there were no differences in their severity of sleep problem scores.

The two groups were very similar in their demographics, attachment patterns, attachment security and resistance scores, the severity of sleep problems, parental nighttime involvement, infant negative emotionality, and parental wellbeing. The two groups were different in their previous BSI attempts and cosleeping practices (intentional vs reactive). However, infants whose parents did not seek help cried longer during the SSP separation episodes and parents who did not seek help scored higher on the difficulty with limit setting subscale of the MCISQ. These two variables were also successful to predict the group membership in 87.5% of the cases.

At Phase-1 there were no correlations between attachment and sleep variables nor were there any significant bi-variate correlations between any secondary variables, attachment, and sleep variables. However, some correlations were above .30 and these were used to run a multiple regression analysis to generate a prediction model for sleep variables. A significant prediction model was generated for the severity of sleep problems and the parental nighttime involvement.

Fifty percent of the variance in the severity of sleep problems at Phase-1 was explained by high parental nighttime involvement (explaining 14% of the variance) higher scores on the feeding subscale of MCISQ which indicate higher concerns around infants being hungry at night (explaining 11% of the variance); and less negative emotionality of the infant during free play (explaining 10% of the variance). Limit setting scores were also in the model but the contribution was not significant. The variance in the parental nighttime involvement at Phase-1 was explained with the severity of sleep problems explaining 22% of the variance and this was the only significant contributor of the prediction model including the cry duration at SSP separation episodes and DASS-21 total score.

Level 1b. Summary of Findings (*n* = 18)

Phase-1 data constituting all variables from participants who completed all phases of the study (*n* =18) were analysed in order to explore the relationship between ISD, attachment, and secondary infant and parent variables. These results are provided in detail in Appendix I. In summary, based on the Richman criteria, all infants had sleep problems. Their attachment patterns, however, were mostly secure (83%) with only three infants with insecure attachment. About 1 in 5 families (22% of the whole sample) practiced intentional cosleeping and all these infants were in the comparison group because these parents did not want to receive an intervention. Infants who had ISD since birth (67%) had higher scores on the severity of sleep problems and their parents were more involved at nighttime. In contrast, infants who developed PSD later had higher scores on negative emotionality and parents who had previously tried sleep interventions (56%) scored higher on the feeding beliefs sub-scale of the MCISQ. More comparison infants had ISD since birth than those in the intervention group. However, the groups did not differ on median for the continuous variables (e.g. MCISQ Limit Setting subscale or Cry Durations at SSP separation episodes).

The severity of sleep problems and attachment resistance was significantly negatively correlated (r = -.50) as was negative emotionality (NE Scale) and the severity of sleep problems (r= -.49). The variance accounted for (VAC) in the severity of sleep problems scores as measured by the Richman scale was as follows: higher parental nighttime involvement (14% VAC), and lower attachment resistance (13% VAC). In return, higher scores on parental nighttime involvement was only explained by higher scores on the severity of sleep problems (30% VAC).

Level 2. The Effectiveness of Behavioural Sleep Interventions on Primary Outcome Variables

In this section changes over time across the phases of the study were analysed by way of visual analysis principles applied to time-series graphs (Cooper et al., 2007) (see Method section above), separately for the intervention and comparison families. First, the effectiveness of BSIs for the treated infants was investigated. Second, changes in the sleep of the untreated infants was examined. Third, the point-per phase severity of sleep problems and parental nighttime involvement scores of intervention and comparison families were analysed using modified Brinley Plots (Blampied, 2017).

Changes in the sleep pattern of infants: Time-series analyses. This section examines changes in sleep patterns, namely, the number of night wakings (Figures 8a, 8b, 11a, 11b), duration of night wakings (Figures 9a, 9b, 12a, 12b) , and the percent of the target duration of total sleep achieved (Figures 10a, 10b, 13a, 13b) using night-by-night data from the sleep diaries. Sleep onset delay (SOD) was not considered as an outcome measure because only two infants (Hamish and Robyn) reported experiencing this problem. In addition, there was a variety of management strategies used by parents at bedtime settling and most of these parents were breastfeeding their infant to sleep; therefore the direction of the change in SOD was different for every infant making it difficult to interpret the overall effectiveness of the intervention by analysing the sleep diary data.

Consistent with the multiple baseline design used to assess BSI, all graphs display a standard X-axis length of 240 days, vertical lines indicate the end of each phase, and the median of Phase-1 is displayed as a horizontal dashed line on each graph. The chosen type of program and the attachment patterns assigned at SSP-1 and SSP-2 were shown for each infant as are the VSG reliability percentages where available.

In what follows, first, the quality of data is considered, including assessment of trend, level, and variability for each outcome variable. Level refers to the magnitude of the data points, relative to possible minima versus maxima. Trend refers to any overall slope in the data path. In this study, as the data was variable, the median score was employed to assist with judging the stability, where 85% of the data need to sit within ± 25% of the median to be considered as stable (Lane & Gast, 2014).

Next, an overall effectiveness of interventions with effect sizes for each individual and each outcome variable are explained using the PEM scores. Treatment integrity and acceptability are reported for those families receiving treatment.

Comparison infants' time-series graphs were also analysed for trend, level, and variability/stability in each phase to detect any changes that may have occurred through time. The outcomes are summarised and compared with the intervention infants' outcomes.

Quality of the data. All participants who completed an intervention (n = 10) and who agreed to provide comparison data (n = 8) provided the sleep diary information for all phases of the study.

Phase durations. The shortest duration of the study with one participant was 132 days (four months) and the longest duration was 239 days (7.9 months). Details are provided in Appendix J.

Illness and missing data. All infants in the study got sick frequently, more so for the infants who received treatment. These nights (and those with any other disruptions of family routine) are indicated on the plots by dark circles. Four intervention and four comparison infants' diaries had missing days owing to sicknesses, as detailed in Appendix J.

Non-compliance. The percentage of parental compliance with the program during Phase-2 was calculated using the Bedtime Soothing Scale and the results are reported at the end of this section. Hamish and Sheryl's routines were disrupted for other reasons than sickness during Phase-2 for four days and six days respectively. After a long period of illness Robyn's family did not want to continue with the planned ignoring part of the parental presence program and they decided to implement their own modification in which, when Robyn signalled her awakening, they stood by the door without going into the room and made soothing noises (i.e. shush) until she fell asleep.

Time series analyses: Intervention infants.

Number of night wakings. Figures 8a and 8b show number of night wakings for the treated infants. At baseline (Phase-1) data were stable enough to permit interpretations. There is little evidence of any systematic trend to improvement in baseline except perhaps for Sheryl but that had levelled out at 1-3 wakings by the end of the phase. This was probably because her parents removed the pacifier and safety blanket at 43rd night of the baseline phase which was considered as the Phase-1-b and the PEM was calculated from the median of these last six days of the baseline. Only two cases (Rebecca and Mike) had some nights with no or one waking, however the rest were problematic.

A change coincident with the introduction of intervention was detectable in all participants. There was a clear treatment effect for all except for Wendy who continued to wake frequently on some nights. Interestingly, despite illness there was no return to baseline level of night wakings in children except for Sheryl who experienced a disruption to the family routine on the last week of the intervention phase. When compared to Phase-1, improvements were maintained by all treated infants during the post-intervention (Phase-3) and follow up (Phase-4).

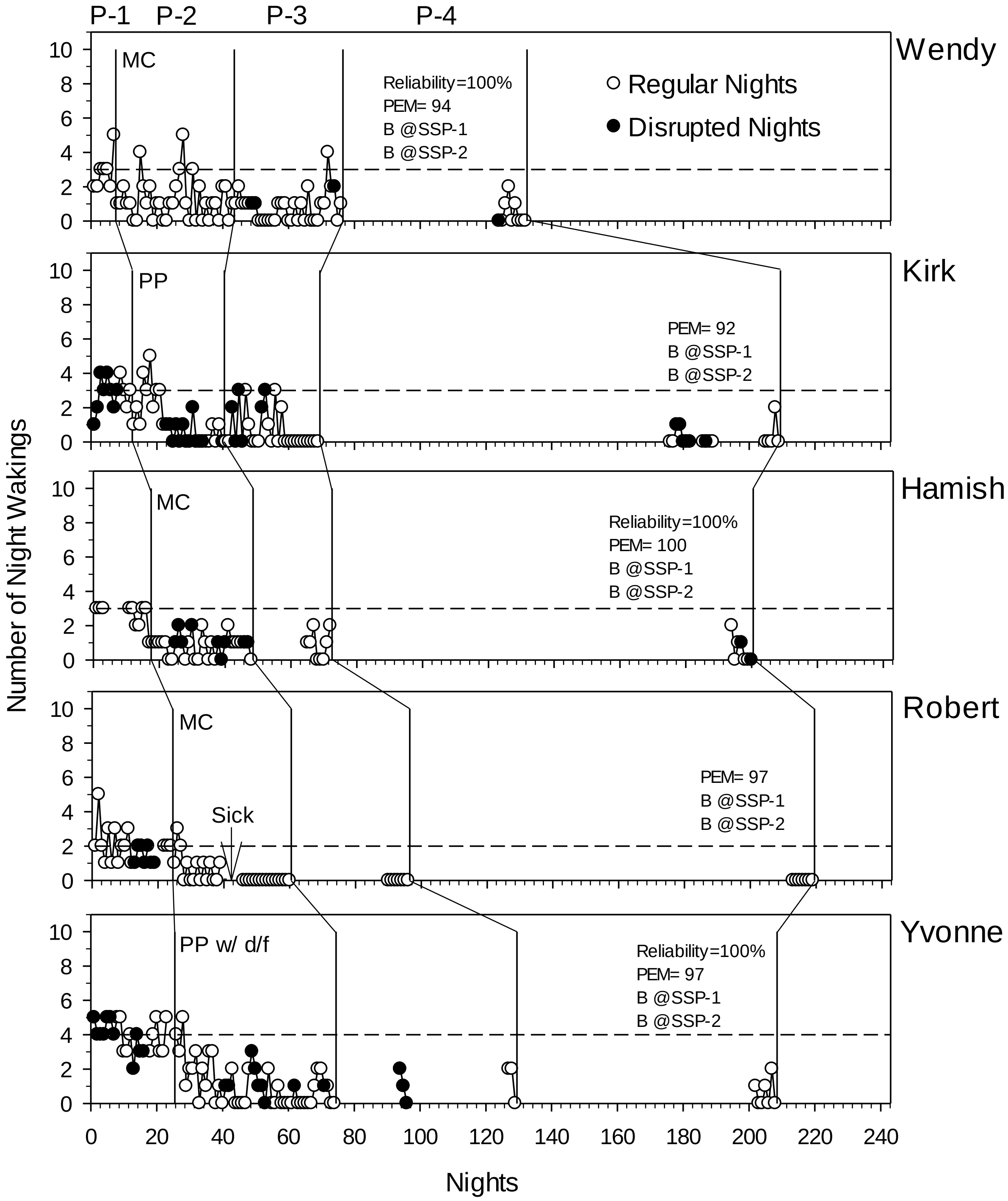

Figure 8a. Number of night wakings of the first five treated infants across phases.

Note. P-1 = Phase-1(baseline), P-2 = Phase-2 (intervention), P-3 = Phase-3 (post-intervention), P-4 = Phase-4 (follow-up). MC = Minimal Check, PP = Parental Presence, PP w/ d/f = parental presence with dream-feeding. Reliability = the percentage of agreement between sleep diary and VSG. Horizontal dashed lines indicate the P-1 median value for each infant. PEM = percentage of data points below the P-1 median at P-2. SSP-1 = the Strange Situation Procedure at P-1. SSP-2 = the Strange Situation Procedure at P-4. B = secure attachment, A = Avoidant attachment, C = resistant/ambivalent attachment pattern.

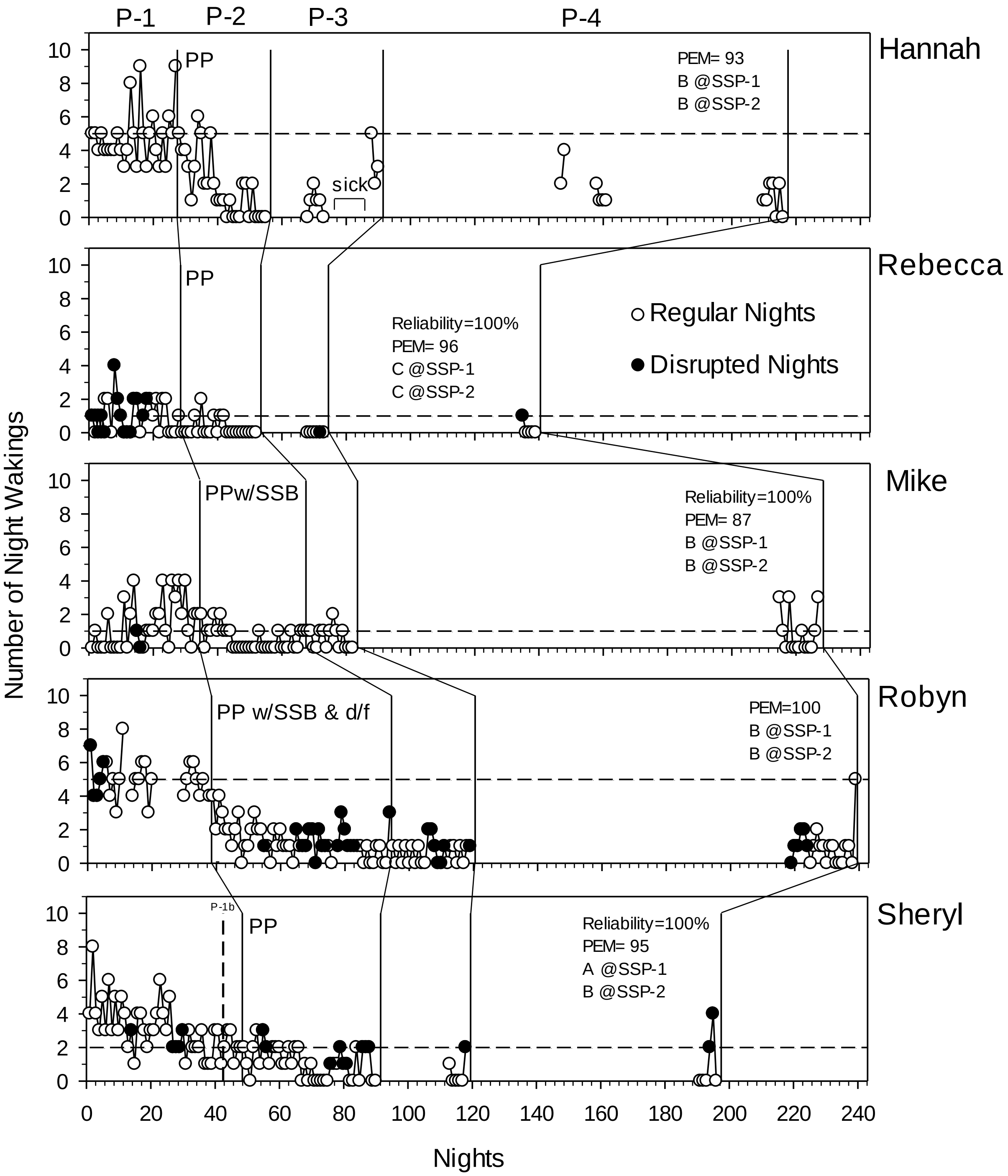

Figure 8b. Number of night wakings of the second five treated infants across phases.

Note. Continued caption from Fig. 8a. SSB = social story book. P-1b = Sheryl's parents removed pacifier and safety blanket at 43rd night of Phase-1 therefore the median of last six days of Phase-1 was used to calculate the PEM.

Duration of night wakings. Changes in the duration of night waking are shown in Figures 9a and 9b for treated infants. In order to prevent undue compression of the Y-axis (scaled in minutes) some outlying data points are not shown (e.g., Yvonne's baseline data in Fig 9a).

The baseline was stable for all participants although NWDUR was generally and consistently more variable than NW. Most, if they woke at all, woke for problematic durations. Most infants, even when not sick, woke for longer than one hour on average except for Hamish who had relatively short waking durations. One night when Yvonne was sick she did not sleep at all and was awake for 10 hours in total.

As a result of intervention, the treatment effect was clear for Wendy, Kirk, Robert, Hannah and Rebecca. Yvonne, Mike and Robyn had evidence of treatment effect but nights of no/short wakings were still interrupted with long wakings, often when sick. Sheryl showed treatment effect by the end of the Phase-2, specifically after the parent left the room to continue with the planned ignoring stage of the intervention. Only Hamish did not show a treatment effect however the NWDUR were not problematic at baseline in any way. At post-intervention and follow up phases (Phases 3 and 4) the improvements were maintained except for Robyn and this was related to illness. She had no awakenings when she was not ill.

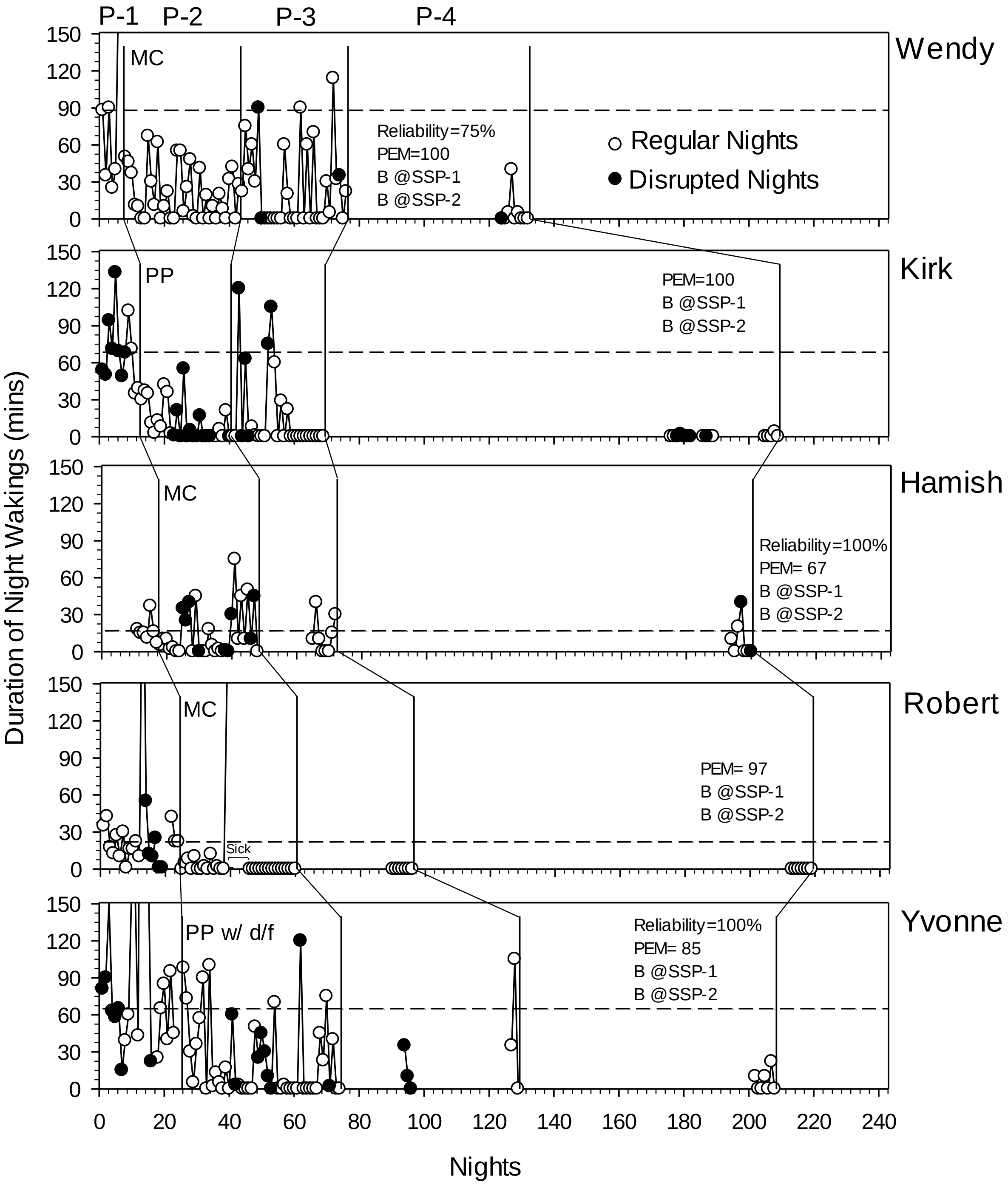

Figure 9a. Total duration of night wakings of the first five treated infants across phases.

Note. Continued caption from Fig. 8a. Some data points are above the maximum value displayed on the graph. This is to prevent the graph points to be compressed as a whole.

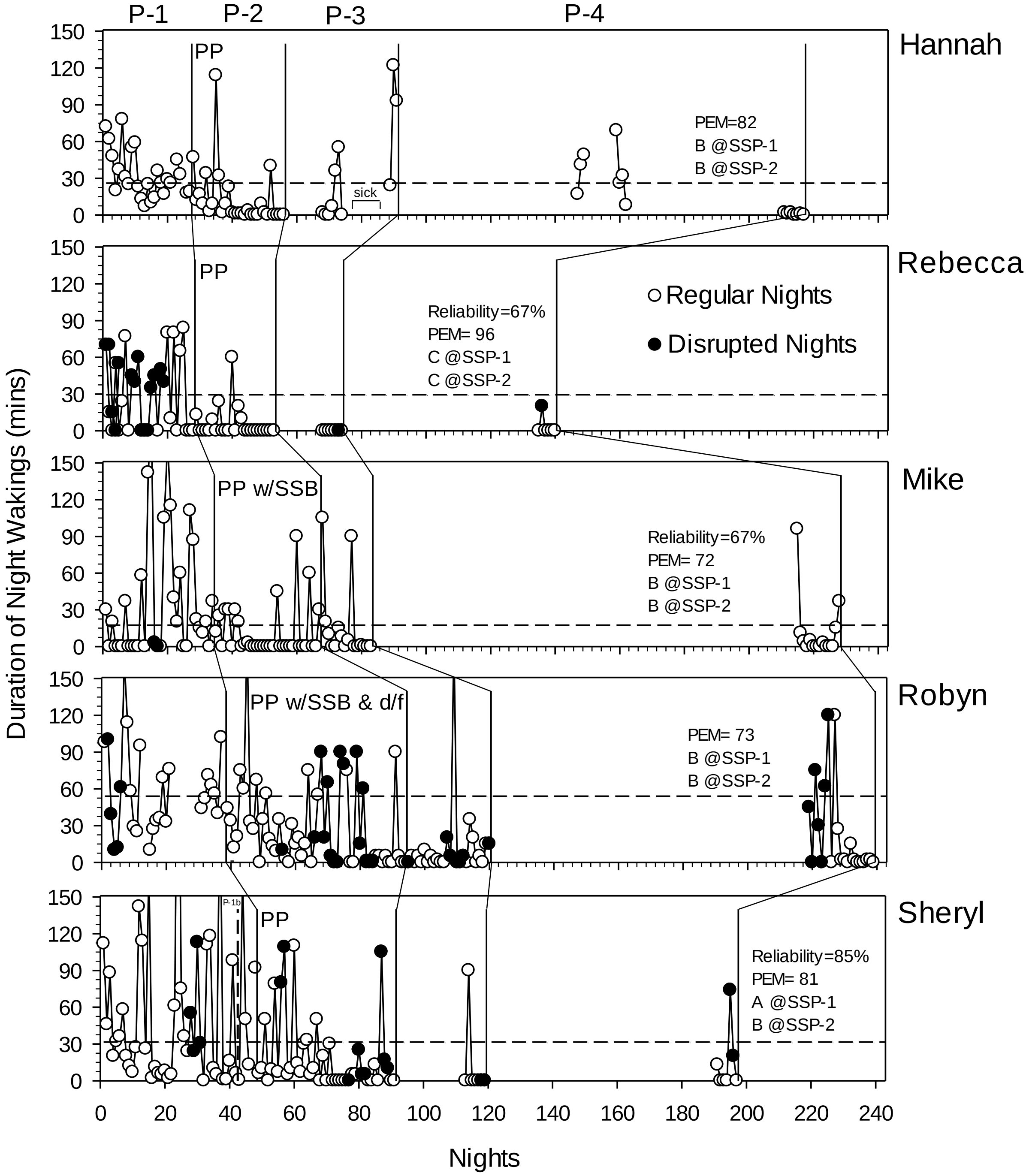

Figure 9b. Total duration of night wakings of the second five treated infants across phases.

Note. Continued caption from Fig. 8a. SSB = social story book. P-1b = Sheryl's parents removed pacifier and safety blanket at 43rd night of Phase-1 therefore the median of last six days of Phase-1 was used to calculate the PEM. Some data points are above the maximum value displayed on the graph. This is to prevent the graph points to be compressed as a whole.

The percentage of target total sleep duration. Figures 10a and 10b show the % of target total sleep duration achieved by the treated infants. The recommended total night sleep duration for 1-2 year-olds by the American National Sleep Foundation (Hirshkowitz et al., 2015) was 11-14 hours and below 9 hours was not recommended for this age. Results of children who received and did not receive intervention are interpreted in accordance with these recommendations where 100% corresponds to 12 hours and below 75% is outside the recommended range of total sleep duration for 1-year-olds.

At baseline (Phase-1) only Sheryl was sleeping less than nine hours meeting the median of 72% of the target sleep duration. Hamish, Robert, and Hannah have either a ceiling effect or upward trend in baseline so inference of a treatment effect cannot be drawn. Other cases are level and sufficiently stable that any treatment effect can be evaluated.

At Phase-2, the treatment effect was evident but mostly small for Kirk, Yvonne, and Rebecca. No clear evidence of treatment effect was seen for Hamish, Robyn, Mike, Robert, and Sheryl but no evidence of deterioration during Phase-2 either in any case.

The maintenance of improvements were evident at Phases 3 and 4 for those who showed improvement at Phase-2. Sheryl, who had the lowest level at Phase -1 with a median of eight hours, increased to 11 hours meeting 91% of the target duration at Phase-3 and the improvement was maintained at Phase-4 except for sick days. Mike was the only infant who had nine hours of total sleep at Phase-4 meeting 78% of the target sleep, lower than Phase-1, which might be related to having new problems with his sleep and parents being back to a new sleep program.

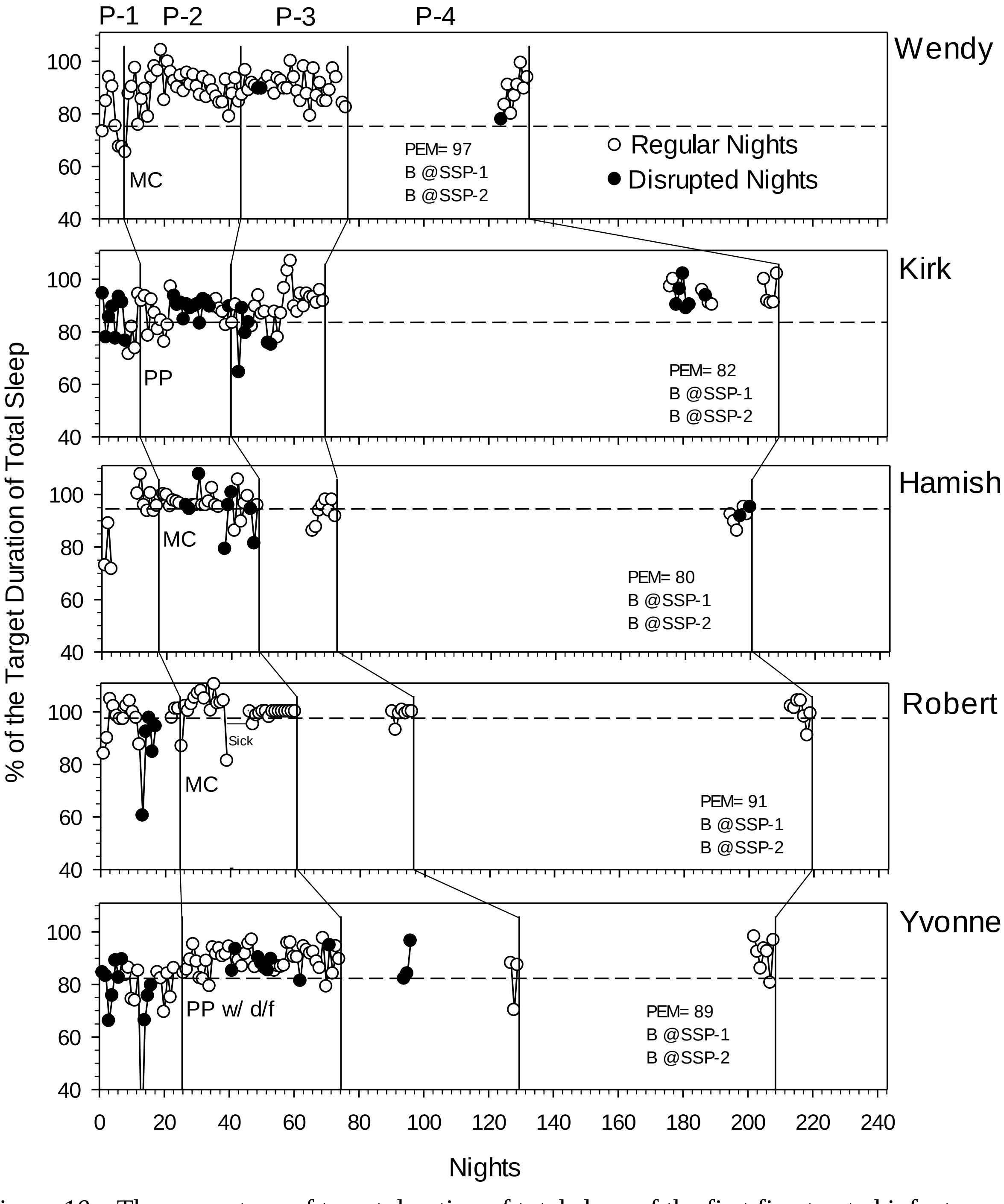

Figure 10a. The percentage of target duration of total sleep of the first five treated infants across phases

Note. Continued caption for Fig. 8a.

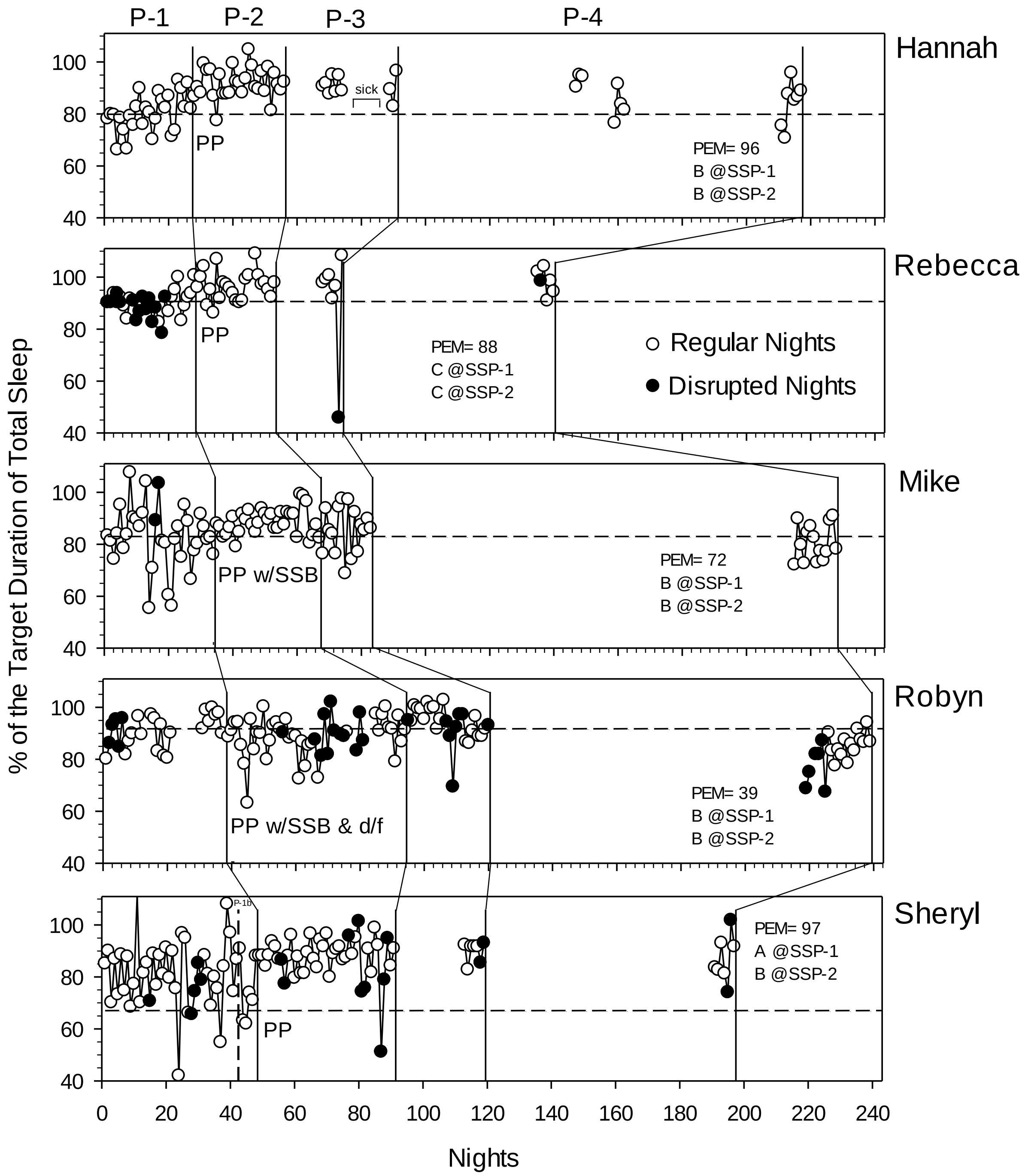

Figure 10b. The percentage of the target duration of total sleep of the second five treated infants across phases.

Note. Continued caption for Fig. 1a. SSB = social story book. P-1b = Sheryl's parents removed pacifier and safety blanket at 43rd night of Phase-1 therefore the median of last six days of Phase-1 was used to calculate the PEM.

The overall effectiveness of the interventions. Table 18 shows the effectiveness of BSIs for each treated infant (*n* =10) and each outcome variable (NW, NWDUR, % of target total sleep duration achieved) using the PEM scores.

For all treated infants, interventions were effective with moderate to high effect sizes. The intervention was highly effective for seven infants. For Mike and Robyn the overall effectiveness of the intervention was moderate. Although the PEM scores of Mike from all variables were above the moderate threshold of effectiveness, he was the one who gained the least benefit from the intervention. Yvonne and Robyn whose parents continued with dream-feeding (see Method, above) seemed to benefit highly from the parental presence to reduce the number of night wakings, however, Robyn's total duration of night waking was not affected at all. This may also be related to their decision to not follow the program after a long period of illness. Although the individual data indicated quite variable duration and frequency of night wakings for infants who implemented the minimal check (Wendy, Robert, and Hamish), their PEM scores indicated high effectiveness on all outcome variables except for Hamish for reasons discussed above.

The implemented interventions, namely minimal check and parental presence with combinations of social story book and dream-feeding, reduced the number of night wakings with the largest effect size (> 90%) followed by duration of night wakings and the % of target duration of total sleep with moderate to high effect sizes. The overall effect size across individuals and variables was 87.8% which is on the upper limit of the moderate to highly effective interventions (Ma, 2006).

Table 18. *Percentage deviating from the Median (PEM) for each participant (n =10) and each dependent variable from the Sleep Diary*

Participant	Number of night wakings	Duration of night wakings	Percentage of the target duration of total sleep	Mean	95% CI (±)
Wendy	**94**	**100**	**97**	97.00	7.45
Kirk	**92**	**100**	82	91.33	22.40
Hamish	**100**	67	80	82.33	41.29
Robert	**97**	**97**	**91**	95.00	8.60
Yvonne	**97**	85	89	90.33	15.17
Hannah	**93**	82	**96**	90.33	18.31
Rebecca	**96**	**96**	88	93.33	11.47
Mike	87	72	72	77.00	21.51
Robyn	**100**	73	39	70.66	75.93
Sheryl	**95**	81	**97**	91.00	21.65
Mean	95.10	85.30	83.10	87.83	6.04
95% CI (±)	2.79	8.85	25.00		

Note. Bold numbers indicate large effect sizes (≥90%) which means the intervention was highly effective. CI = confidence interval.

Treatment integrity and acceptability. As shown in Table 19 parental compliance with the program was between 80 to 100% except for Robyn's parents who continued with their version of the program after a long period of sickness. Nevertheless they were still satisfied with the program.

All parents were satisfied with the intervention they received. Parents of Yvonne and Hamish were the least satisfied and Mike and Robert's parents were the most satisfied. This is interesting because Mike received the least benefit from the program.

In the evaluation interview, the biggest complaint from the help-seeking parents was the difficulty with enduring the baby's cries during the first two weeks of the program. However, parents also reported that being informed about the progress of behaviour change at the program set-up interview and having the constant support with daily contact throughout the intervention phase helped them to cope better with these difficulties.

Table 19. *Follow-up scores of parents (n = 10) on treatment acceptability as measured by Treatment Evaluation Inventory-Short Form and treatment integrity as measured by Nighttime subscale of the Bedtime Soothing Scale*

Participants	Treatment Evaluation Inventory-Short Form*	Parent compliance with the program (%)
Wendy	43	83
Kirk	42	93
Hamish	37	84
Robert	45	96
Yvonne	36	87.5
Hannah	39	100
Rebecca	41	100
Mike	45	100
Robyn	42	71
Sheryl	42	80

Note. * Possible score range = 0- 45; highest scores indicate more positive response.

Change through time: Comparison infants.

Number of night wakings. Figures 11a and 11b show number of night wakings for the comparison infants. At Phase-1 all comparison infants also woke regularly and frequently and the data were stable to make inferences on Phase-2. Six children woke three or more times a night, which may be considered high level of frequency (Richman, 1985). Even those children who woke less frequently still woke very regularly.

There was no systematic change observed in Phase-2 except for Alan and Ben whose NW improved. At Phase-3 and Phase-4 the NW remained stable for most children except for Harrison, Alan and Leila, as well as Peter who showed a slight decrease but no dramatic change.

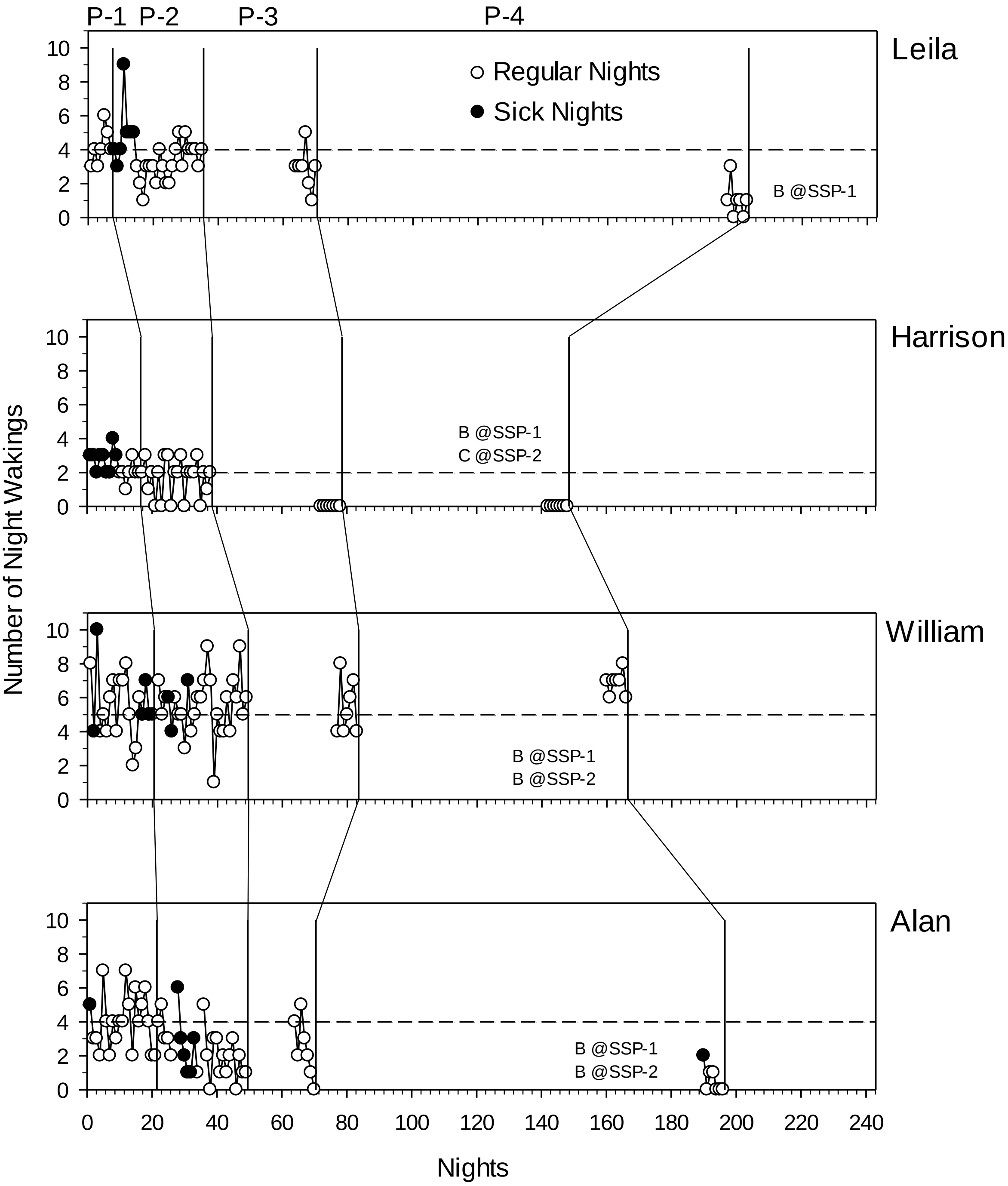

Figure 11a. Number of night wakings of the first four comparison infants across phases.

Note. Continued caption from Fig. 8a. Horizontal dashed lines indicate the P-1 median value for each infant.

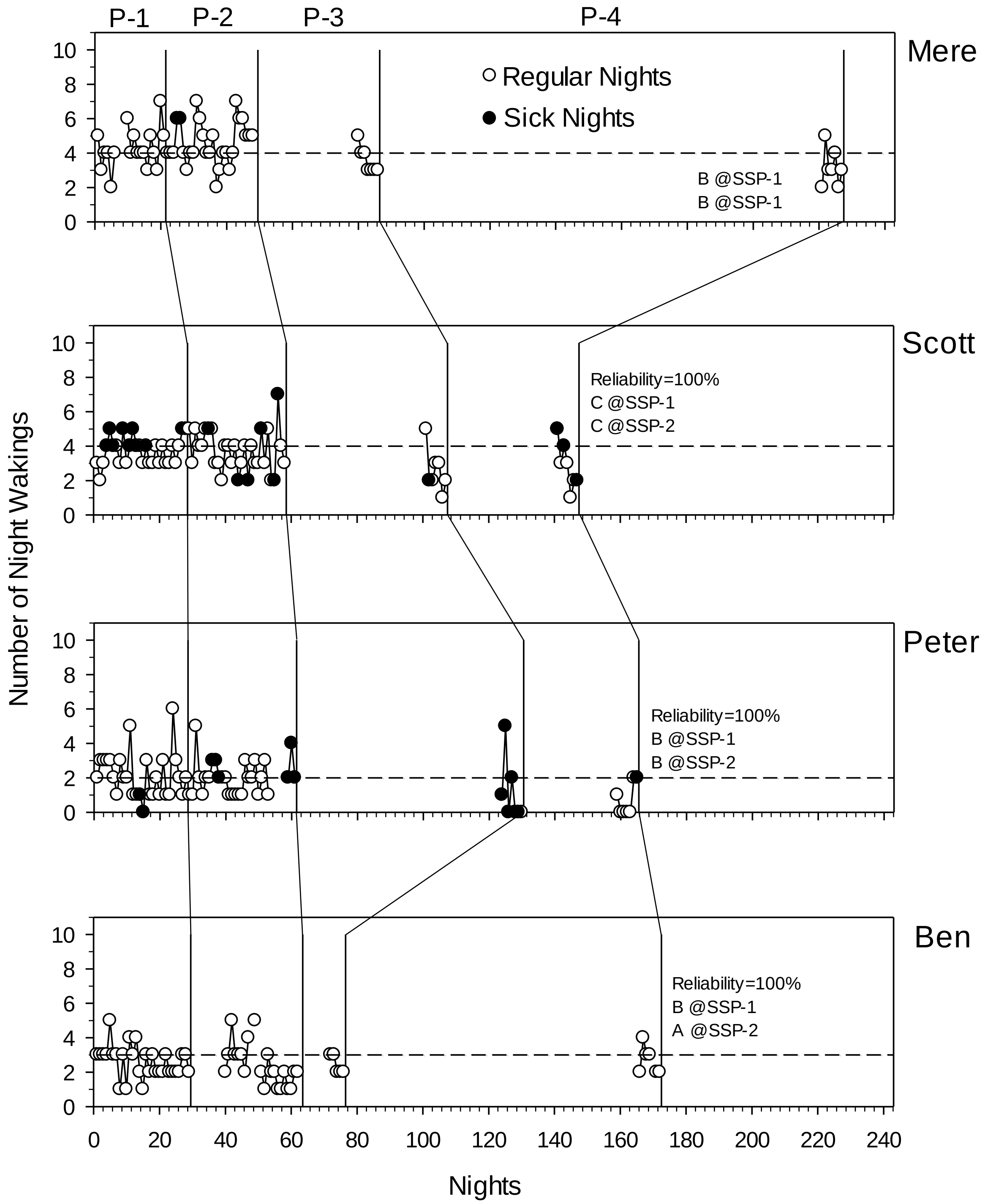

Figure 11b. Number of night wakings of the second four comparison infants across phases.

Note. Continued caption from Fig. 8a. Horizontal dashed lines indicate the Phase-1 median value for each infant.

Duration of night wakings. Changes in the duration of night wakings are shown in Figures 12a and 12b for the comparison infants. In order to prevent undue compression of the Y-axis (scaled in minutes) some outlying data points are not shown (e.g., William's baseline data in Fig 12a).

At Phase-1 the data were generally stable although there was a floor effect and lack of problem for Harrison who typically woke 2-3 times a night. His parents were practicing intentional cosleeping and he was breastfed to sleep every time he woke up at night. Although frequency of night wakings were stable, Leila and Alan showed declining levels of NWDUR in baseline.

Data paths characteristic of baseline continued at Phase-2. Where night waking durations were problematic at the end of baseline they remained problematic during Phases 3 and 4 except for Ben whose waking durations had less variability. Scott got worse by the end of Phase-4. Leila's awakenings showed a cyclic pattern with decreasing and increasing durations throughout Phases 2 and 3 with maintained high variability, Phase-4 levels were lower than Phase-1 with maintenance of variability.

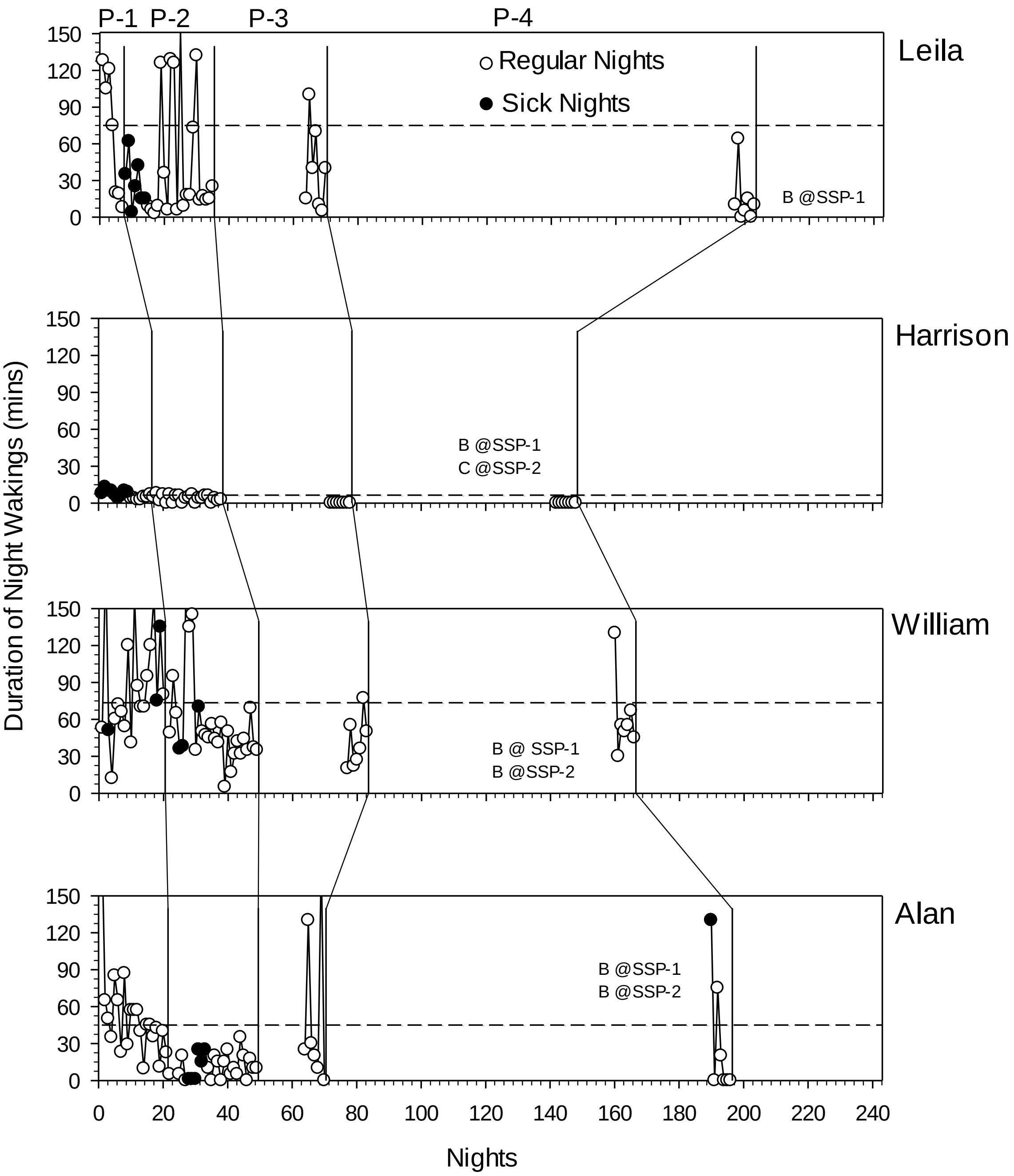

Figure 12a. Total duration of night wakings of the first four comparison infants.

Note. Continued caption from Fig. 8a. Horizontal dashed lines indicate the Phase-1 median value for each infant. Some data points are above the maximum value displayed on the graph. This is to prevent the graph points to be compressed as a whole.

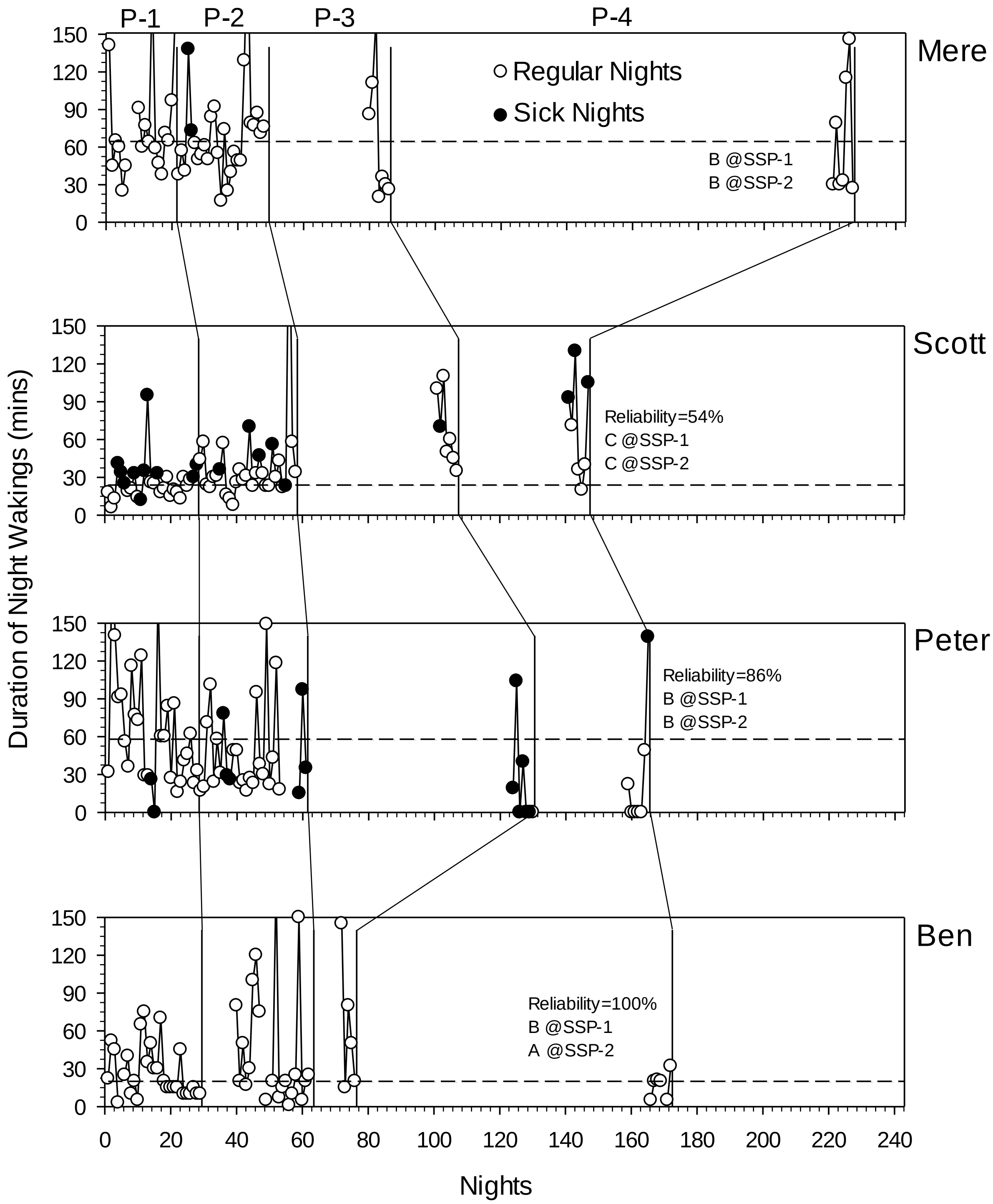

Figure 12b. Total duration of night wakings of the second four comparison infants.

Note. Continued caption for Fig. 8a. Horizontal dashed lines indicate the Phase-1 median value for each infant. Some data points are above the maximum value displayed on the graph. This is to prevent the graph points to be compressed as a whole.

The percentage of target total sleep duration. Figures 13a and 13b show the % of target total sleep duration achieved by the comparison infants. At Phase-1 comparison infants were homogeneous and the data were stable. All infants were sleeping around 10 hours per night, meeting between 80- 83% of the target duration. There was no change evident at Phase-2 for any children except for William who slightly improved and Scott who deteriorated due to sickness. There were no systematic changes observed in Phases 3 and 4.

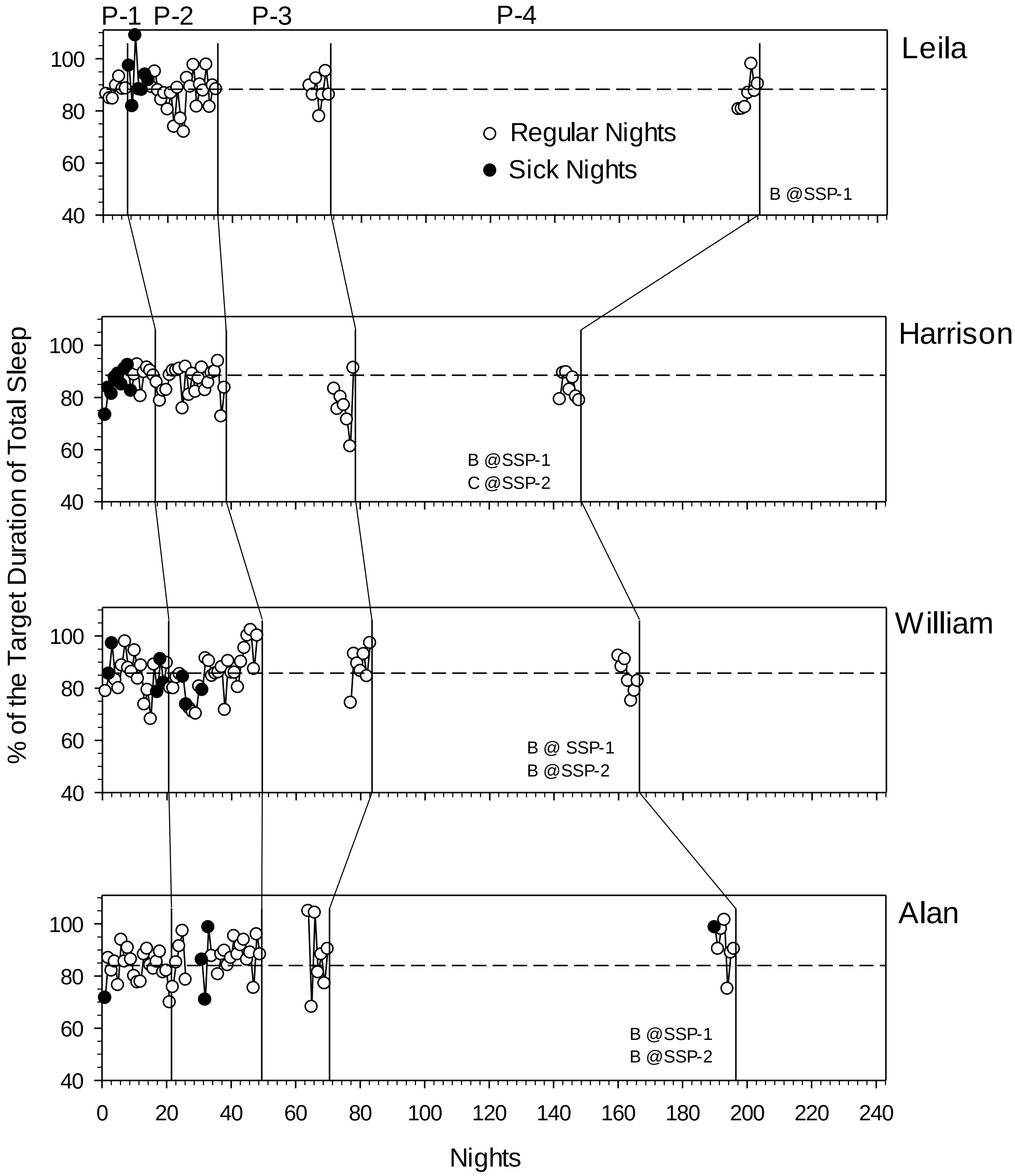

Figure 13a. The percentage of the target duration of total sleep of the first four comparison infants across phases.

Note. Continued caption for Fig. 8a. Horizontal dashed lines indicate the Phase-1 median value for each infant.

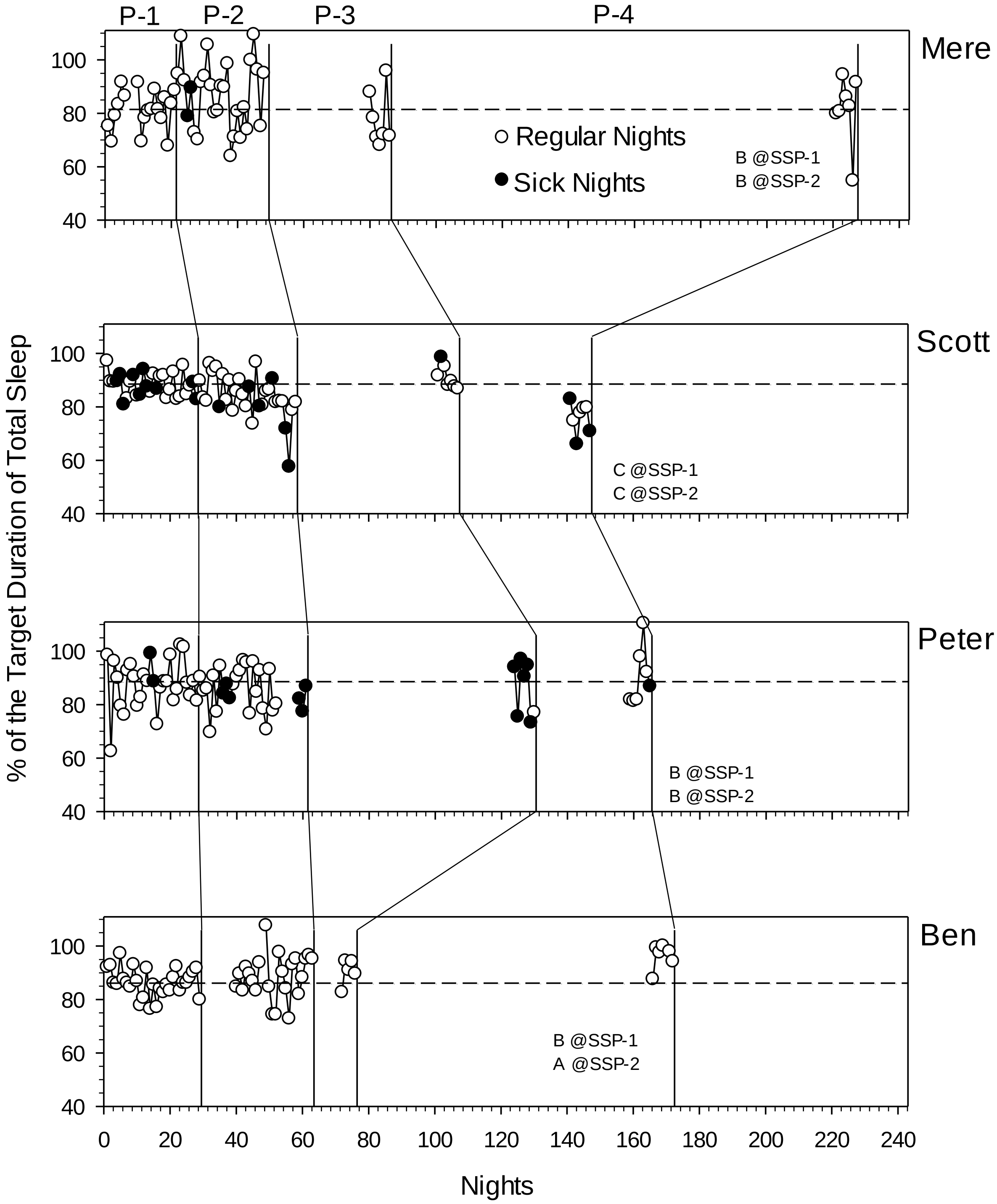

Figure 13b. The percentage of the target duration of total sleep of the second four comparison infants across phases.

Note. Continued caption for Fig.8a. Horizontal dashed lines indicate the Phase-1 median value for each infant.

Summary of findings with comparison infants. There was a natural but not dramatic decline observed in number and duration of night wakings of all comparison infants, even when there were no interventions applied, from Phase-1 to Phase-4 with two infants displaying a pseudo-treatment effect. However, the achieved % of target total sleep tended to decline from an acceptable level of 83% to the lower boundary of 75% (approximately nine hours) per night with only two infants showing some improvement compared to the Phase-1 median level.

Comparing findings for intervention and comparison infants. All infants began the study showing a similar sleep pattern of waking regularly and frequently for at least 15 minutes per night and achieving around 9 to 10 hours of total sleep with a few exceptions. Most children in both groups showed consistent variability in the duration of night wakings.

The differences between intervention and comparison infants became visible by Phase-2 as intervention infants' sleep patterns markedly improved and the improvements were maintained through Phases 3 and 4 while comparison infants' awakenings continued showing variability with a slight decreasing trend.

The main difference occurred in the achieved % of target total sleep by the end of Phase-4. While most of the intervention infants at Phase-1 were sleeping around 9 hours per night and most of the comparison infants were sleeping around 10 hours per night, all intervention infants except one were sleeping 10 or more hours per night by end of Phase-4 while only four comparison infants were still sleeping around 10 hours per night and the other four deteriorated from Phase-1 to Phase-4.

Changes in the point-per-phase sleep variables: Modified Brinley Plots. In what follows, modified Brinley Plots of the severity of sleep problems and parental nighttime involvement scores are displayed in order to analyse changes across phases within and between participants (see Figures 3 and 4 in Method chapter Analysis section for an example of interpretation). Results from the nonparametric tests were reported along with the visual analyses of the MBPs. The Wilcoxon Rank Sum Test for repeated measures was conducted to compare within-group changes in scores from Phase-1 to Phase-4. The Mann-Whitney U-test for independent samples was conducted to compare the Phase-4 scores of intervention and comparison groups. The probability of superiority (*A*) effect size measure for nonparametric tests was also calculated for the Mann-Whitney *U*-Test results (Ruscio, 2008).

The severity of sleep problems. Figure 14 displays the Richman's CSS of both intervention and comparison infants, across four phases. Scores of all infants who received an intervention markedly reduced from Phase-2 through to Phase-4 relative to baseline. In fact, the Phase-4 scores of the intervention infants (*Mdn* = 13.5) were statistically significantly lower than their Phase-1 scores (*Mdn* = 4.5) for the severity of sleep problems (Z = -2.812, p = .005).

At follow-up (Phase-4) all intervention infants were no longer defined as having a sleep problem using Richman's CSS criterion, except for two who had scores on or one point above the cut-off score of eight for having a sleep problem. As seen in Figure 14, children with lower scores at Phase-1 seem to have shown the largest reduction in severity by Phase-4, whereas infants with higher scores show less change.

There was also a visible reduction in comparison infants' CSS scores from Phase-1 (*Mdn* = 15) through to Phase-4 (*Mdn* = 11.5) and the difference between Phase-1 and Phase-4 Richman's CSS scores of comparison infants was statistically significant (Z = -2.176, p = .030). However, the infant with the lowest score was still at the cut-off, which means at

Phase-4 all comparison infants were still rated as having a sleep problem with four children (22%) above the severe ISD score (Richman's CSS >12). The same pattern in which those with lower scores showed most improvement can also be seen in the comparison children as well.

The difference between Phase-4 scores of two groups was statistically significant with a large effect (U = 2.000, p = .001, A = 0.97).

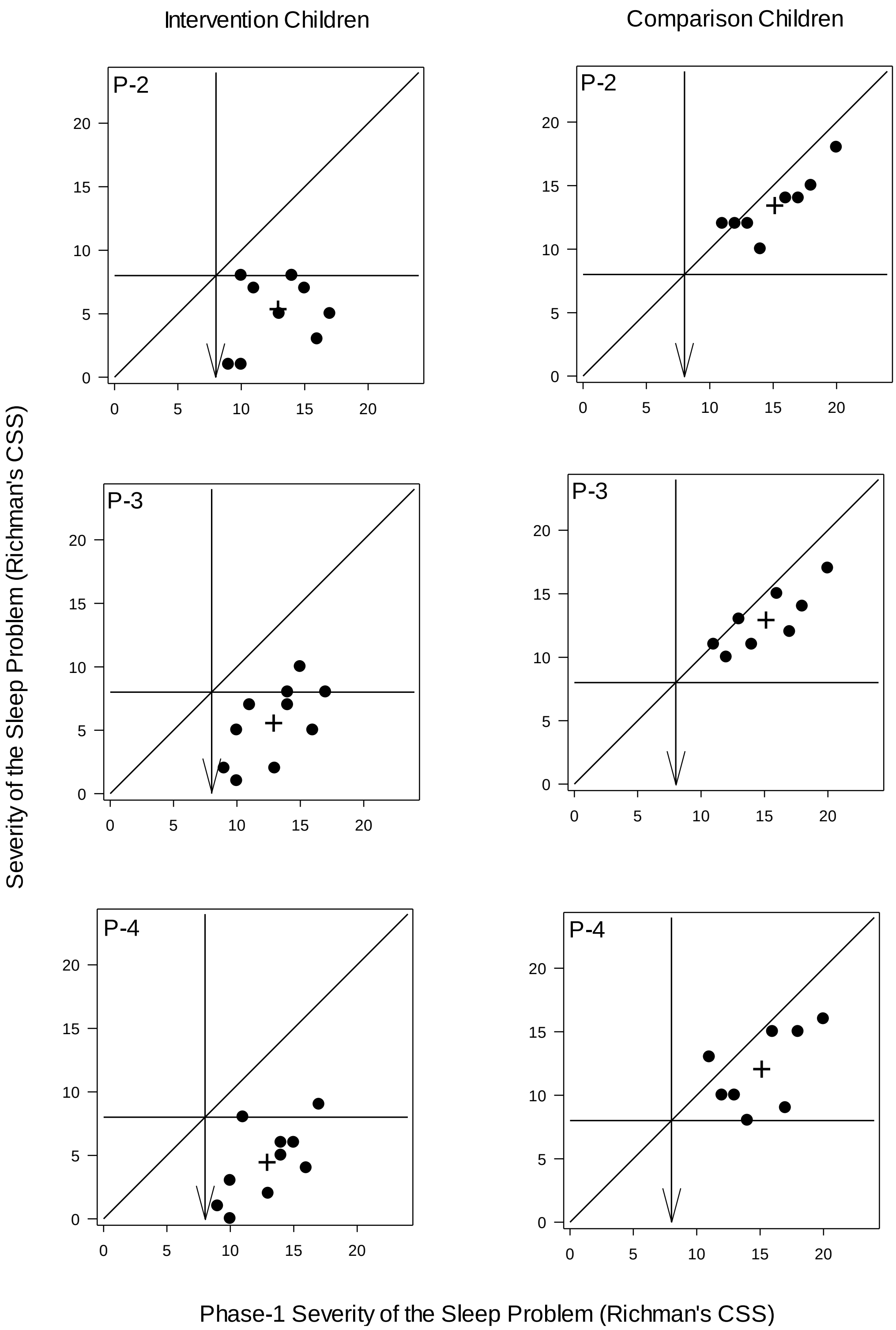

Figure 14. Modified Brinley Plot of the severity of sleep problems scores for intervention and comparison children.

Note. Individual scores on Phase-1 displayed on x-axis plotted against each individual's scores on following phases displayed on y-axis. P-2 = Phase-2, P-3 = Phase-3, P-4 = Phase-4. Plus (+) sign indicates P-1 group mean value on x-axis plotted against the group mean value of the corresponding phase on y-axis. Arrow indicates the direction of change. Orthogonal line indicates no change. The cut-off score is below 8 for no sleep problems.

Parental nighttime involvement. Figure 15, displays parental nighttime involvement as measured by the average of bedtime and nighttime BSS from the same week of the calculated Richman's CSS. Parental involvement for the treated infants markedly dropped across phases. Although one parent increased their involvement in Phase-4 (Hannah's parent was back to occasional cosleeping), average scores remained clearly below the cut-off score and the change from Phase-1 (Mdn = 4.33) to Phase-4 (Mdn = 1.62) in the nighttime involvement scores of intervention parents was statistically significant (Z = -2.803, p = .005). This data confirm that, consistent with instructions for the interventions, parents did reduce their parental involvement at bedtime. In comparison, much less change in parental involvement is displayed by comparison group parents, and all scores remained above the cut-off, except for one case at Phase-4. The difference between the Phase-4 scores of two groups was statistically significant with a large effect (U = 1.000, p = .000, A = 0.98).

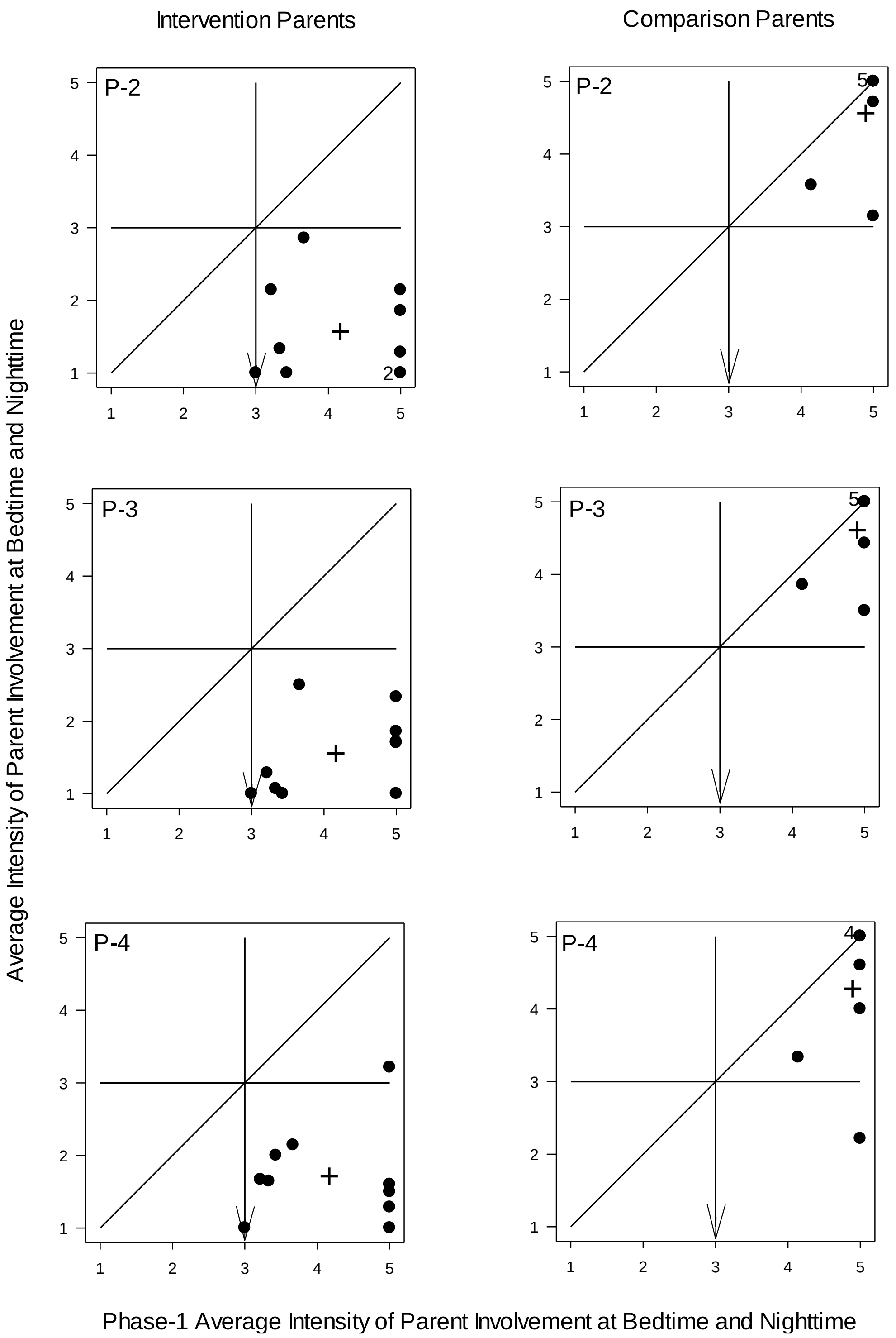

Figure 15. Modified Brinley Plot of the parental nighttime involvement for intervention and comparison children.

Note. Individual scores on Phase-1 displayed on x-axis plotted against each individual's scores on following phases displayed on y-axis. P-2 = Phase-2, P-3 = Phase-3, P-4 = Phase-4. Plus (+) sign indicates P-1 group mean value on x-axis plotted against the group mean value of the corresponding phase on y-axis. Arrow indicates the direction of expected change. Orthogonal line indicates no change. The cut-off score is 3 for low involvement. Numbers on the plot points indicate the number of participants with the exact x and y-axis scores.

Level 3. The Analysis of Change in Attachment and Secondary Variables within and across Participants through Four Phases

In this section, data collected as one data point-per-phase were plotted for intervention and comparison participants, one point plotted relative to another time point, to reveal the direction and extent of change for each individual relative to their prior state and in the context of change in other participants, using modified Brinley Plots (MBP) (Blampied, 2017) (see Figures 3 and 4 in Method chapter Analysis section for an example of interpretation). In addition to the visual analysis of MBPs, the differences within groups from Phase-1 to Phase-4 and between groups at Phase-4 were statistically analysed.

Dependent variables presented in this section are (1) attachment security scores calculated from SSP interactive attachment behaviour scales scores using the modified Richters' Formula, (2) attachment ABC patterns and secure/insecure attachment groups (3) cry duration at SSP separation episodes, (4) infant's observed negative emotionality scale score, (5) parental cognitions about infant sleep measured by MCISQ limit setting, anger, doubt and feeding subscales, (6) parental wellbeing measured by DASS-21 subscales of depression, anxiety, and stress, (7) parental daytime sensitivity as measured by Mini-MBQS-V-Revised. These variables were found to have significant associations with sleep and attachment variables at the first level of analysis (i.e. Level 1a and Level 1b) except for parental daytime sensitivity. MBPs of other variables may be found in Appendix K.

Quality of the data. All participants, both those who completed an intervention (*n* =10) and who agreed to provide comparison data (*n* =8), provided data for these variables for all phases of the study. Only one comparison group parent did not agree to replicate the SSP at Phase-4, therefore *n* = 7 for the attachment security and cry duration at SSP separation episodes.

Analysis. In this section, data collected as one data point-per-phase were plotted for intervention and comparison participants, one point plotted relative to another time point, to reveal the direction and extent of change for each individual relative to their prior state and in the context of change in other participants, using modified Brinley Plots (MBP) (Blampied, 2017). In addition to the visual analysis of MBPs, the differences within groups from Phase-1 to Phase 4 and between groups at Phase-4 were statistically analysed.

All MBP's except attachment security and cry duration at SSP separation episodes used individual baseline scores as the reference (x-axis), against which were plotted pairwise the same individual's data for Phase-2, Phase-3, and Phase-4 (y-axis). Attachment security scores and cry duration at SSP separation episodes were plotted as Baseline versus Phase 4 since measures were taken for these variables only at those time points. Intervention and comparison participants' data were displayed in side-by-side plots for each DV.

In addition, the reliable change index (RCI) (Jacobson & Truax, 1991) is shown for the DASS-21 MBPs (see Method chapter for details). The dashed lines below and above the 45^0 line indicate the RCI boundaries. Data points outside (i.e., below or above) these dashed lines indicate a reliable change, i.e., a change larger than that likely due to measurement error alone.

For categorical attachment patterns, the within group changes from Phase-1 to Phase-4 and between group differences at Phase-4 were analysed with the χ^2 test. For continuous attachment and secondary variables, the within-group changes from Phase-1 to Phase-4 were tested using the Wilcoxon Signed Rank Test and between-group differences at Phase-4 were tested with the Mann-Whitney *U*-test. The Probability of superiority effect size (*A*) was employed to demonstrate the size of the change for between-group differences at Phase-4 (Ruscio, 2008). The point-biserial correlations (r_{pb}) were calculated (P. D. Ellis, 2010) to identify (1) the extent of variance predicted by the Phase-1 categorical attachment security; (2) the extent of variance associated with the Phase-4 categorical attachment security for the improvements in sleep variables from Phase-1 to Phase-4 and the severity of sleep problems at Phase-4. As part of this, the Richman's CSS change score was also calculated (by subtracting the Phase-1 Richman's CSS from Phase-4 Richman's CSS).

Attachment variables. Figure 16 displays the attachment security scores calculated with the modified Richters' Formula (see Method above for details). Zero was the cut-off score for secure (above 0) and insecure (below 0) attachment. Figure 17 displays the bar graph of the distribution of normative attachment patterns (ABC) of the intervention (n =10) and the comparison (n = 7) infants who were assessed with the Strange Situation Procedure at Phase-1 and Phase-4.

According to the MBP of attachment security scores, most children were already rated as within the secure attachment zone at Phase-1 (Figure 16), except for two infants in the intervention and one infant in the comparison group, with another comparison group infant sitting right at the cut-off point (0).

By Phase-4 changes in the attachment security scores were evident for both groups of infants, however these were in opposite directions. By Phase-4 most infants who received an intervention not only remained within the secure zone; their scores increased. The most important change was that one child changed from insecure attachment score at Phase-1 to secure at Phase-2. The other infant with an insecure attachment score remained insecure. This change was also statistically significant when the Phase-1 and Phase-4 categorical attachment patterns (ABC) of intervention infants were compared (χ^2 = 10.00, df = 2, p = .007). In addition, the change in secure ($n_{\text{P-1}}$ = 8 to $n_{\text{P-4}}$ = 9) versus insecure ($n_{\text{P-1}}$ = 2 to $n_{\text{P-4}}$ = 1) attachment groups was also significant within intervention infants (χ^2 = 4.444, df = 1, p = .035).

As displayed in Figure 16, four comparison infants who were rated as secure at Phase-1 all remained secure with a slight decrease in scores. However, one infant who was secure at Phase-1 deteriorated to insecure at Phase-4, one insecure infant's score slightly improved at Phase-4 but remained insecure. The infant who was on the cut-off point at Phase-1 deteriorated to insecure at Phase-4. Therefore the group mean of the comparison infants showed a decrease below the mid-line but still remained within the secure zone. The change in attachment patterns of comparison infants, although statistically not significant, was also visible (See Fig 17) as two infants who had B pattern at Phase-1 moved to A and C respectively and one infant with C pattern remained the same.

The change from Phase-1 to Phase-4 in the median attachment security scores of within-intervention infants and within-comparison infants were not statistically significant when tested with the Wilcoxon Rank Sum Test. Mann-Whitney *U*-test results also did not indicate a statistically significant difference between the attachment security scores of intervention and comparison infants at Phase-4. Moreover, attachment patterns of 14 out of 17 infants (Figure 17) remained stable from initial (SSP-1) to final assessment (SSP-2) as categorised with the organised ABC coding (Cohen's *Kappa* = .490, p = .011). However, the change in the categorical patterns of attachment (ABC) from Phase-1 to Phase-4 for all participants was statistically significant (χ^2 = 10.711, df = 4, p = .030).

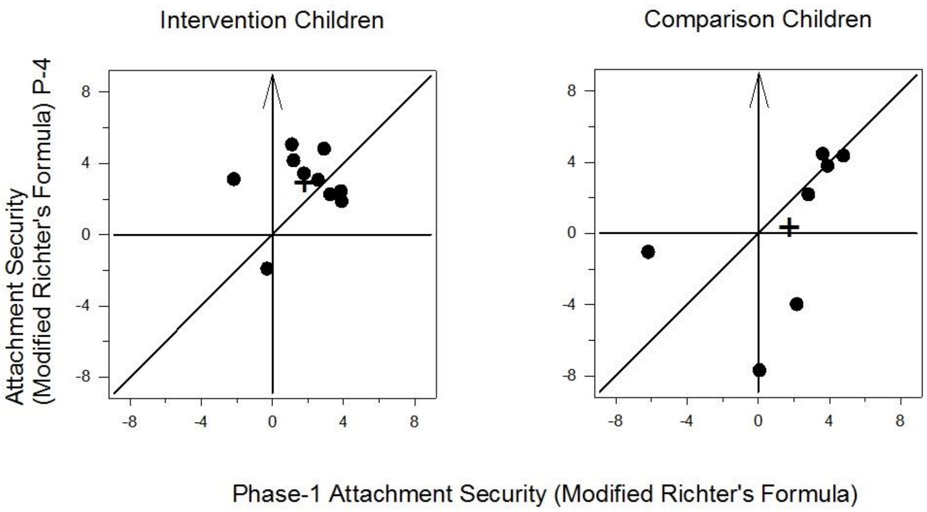

Figure 16. Modified Brinley Plot of the attachment security scores for intervention and comparison infants calculated with the modified Richters' Formula.

Note. Individual scores from SSP-1 displayed on x-axis plotted against each individual's scores from SSP-2 displayed on y-axis. P-4 = Phase-4. Plus (+) sign indicates P-1 group mean value on x-axis plotted against the group mean value of the P-4 on y-axis. Arrow indicates the direction of expected change. Orthogonal line indicates no change. The cut-off score is zero for secure vs insecure.

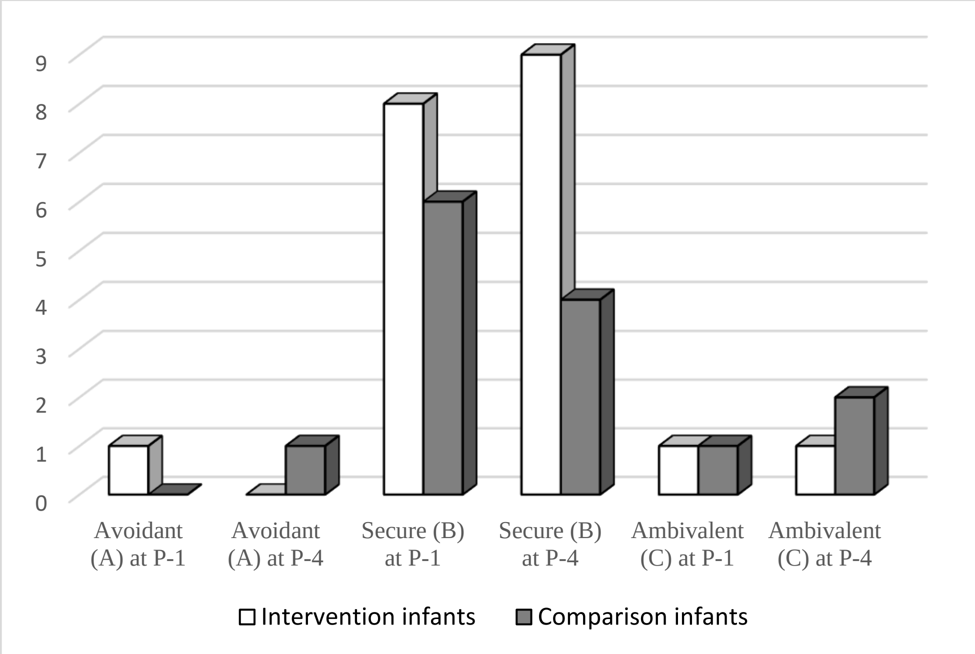

Figure 17. Bar graph of the distribution of normative attachment patterns (ABC) of the intervention (*n* =10) and the comparison (*n* = 7) infants who were assessed with the Strange Situation Procedure at Phase-1 (P-1) and Phase-4 (P-4).

The point-biserial correlations between secure/insecure attachment groups and the severity of sleep problems. In order to detect whether having secure or insecure attachment was predictive of and concurrently associated with the changes in the sleep problems in each group, point-biserial correlations were calculated between parental nighttime involvement (the average BSS scores), the severity of sleep problems at Phase-4 (Richman CSS), and the Richman CSS change score from Phase-1 to Phase-4 and (1) secure/insecure attachment groups at Phase-1; (2) secure/insecure attachment groups at Phase-4, for comparison and intervention families separately.

Point-biserial correlations between secure/insecure attachment groups at Phase-1 and sleep variables at Phase-4 with intervention (n =10) and comparison (n =8) infants. For comparison families, only 8.2% of the variance in parental nighttime involvement at Phase-4 was predicted by the attachment insecurity of the infant at Phase-1 indicating a small-medium effect size (r_{pb} = -.287, r^2 = .082). However, 46% of the variance in the improvement of the severity of sleep problems from Phase-1 to Phase-4 was predicted by the attachment security of the infant at Phase-1 indicating a large effect size (r_{pb} = .680, r^2 = .46) which means the sleep pattern of secure infants, even without intervention, tended to improve over six months.

For intervention families, 10% of the variance in parental nighttime involvement at Phase-4 was predicted by the attachment security of the infant at Phase-1 (r_{pb} = .329, r^2 = .10) indicating a medium effect size. In addition, 11% of the variance in the severity of sleep problems scores at Phase-4 was predicted by the attachment security of the infant at Phase-1, a medium effect size (r_{pb} = .339, r^2 = .114), whereas 10% of the variance in the improvement of the severity of sleep problems from Phase-1 to Phase-4 was predicted by the attachment insecurity of the infant at Phase-1, again, a medium effect size (r_{pb} = -.321, r^2 = .103). This is congruent with the observation that intervention infants who were insecure at Phase-1 showed more improvement in their sleep pattern from Phase-1 to Phase-4.

Point-biserial correlations between secure/insecure attachment groups at Phase-4 and sleep variables at Phase-4 for intervention (n =10) and comparison (n = 7) infants. For comparison families, the severity of sleep problems at Phase-4 was not associated with the Phase-4 attachment secure/insecure categories. However, 22% of the variance in parental nighttime involvement at Phase-4 was explained by the attachment insecurity of the infant at Phase-4 indicating a large effect size (r_{pb} = -.474, r^2 = .224), and 61% of the variance in the improvement of the severity of sleep problems from Phase-1 to Phase-4 was further explained by the attachment security of the infant at Phase-4, indicating a large effect size (r_{pb} = .782, r^2 = .611, p = .038), which means that comparison infants who remained secure at both assessments (n = 4) showed most of the improvement in sleep patterns from Phase-1 to Phase-4.

For intervention families, the variance in the improvement of sleep problems from Phase-1 to Phase-4 was not explained by the attachment secure/insecure categories at Phase-4 as the point-biserial correlation was <.10, whereas 14 % of the variance in parental nighttime involvement at Phase-4 was explained by the attachment security of the infant at Phase-4, r_{pb} = .382, r^2 = .14; with a large effect size. In addition, 16% of the variance in the severity of sleep problems scores at Phase-4 was explained by the attachment security of the infant at Phase-4, with a large effect size (r_{pb} = .405, r^2 = .164).

Infant negative emotionality. Two NE measures, namely, cry durations at SSP Separation Episodes and the NE Scale are reported. The MBPs of two other measures, Perceived NE as measured by ICQ and frequency of observed NE behaviours can be found in Appendix K.

Cry duration at SSP separation episodes. Developmentally, the cry durations at SSP separation episodes are expected to decrease over time because infants of 18 months (i.e., toddlers), start utilising language to communicate their distress (Ainsworth et al., 1978). Therefore the expected change was towards decrease in the total cry duration at SSP separation episodes.

At Phase-1, when the mean age of infants was 13 months, infants experiencing an intervention showed more variability in cry durations, with a range from no crying to long durations (e.g. > 2 mins) or strong enough to terminate the separation episode after 30 seconds (Figure 18). At the second SSP, these children showed two kinds of change; some slightly increased their cry durations and others substantially reduced their durations, so that the mean shows a small reduction over time. In contrast, the comparison infants typically cried for >15 mins during the first SSP and showed either large increases or small decreases in crying at the second SSP, so that the group mean shows a small increase in duration.

Additionally, the comparison children's median score on the Phase-4 cry durations at SSP separation episodes (*Mdn* = 27) was higher than the median Phase-4 score of the intervention children (*Mdn* = 12) with a large effect (U = 11.000, p = .019, A = 0.86).

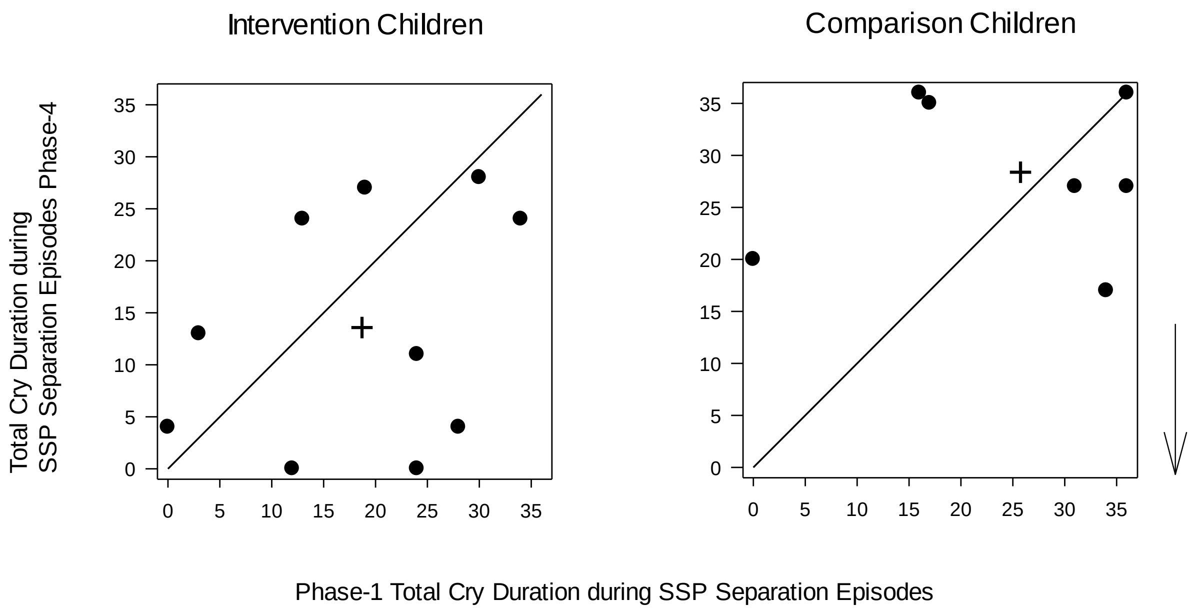

Figure 18. Modified Brinley Plot of the Total cry duration during SSP separation episodes for intervention and comparison children calculated in 15 seconds intervals on episodes 4, 6, and 7.

Note. Individual scores from SSP-1 displayed on x-axis plotted against each individual's scores from SSP-2 displayed on y-axis. P-4 = Phase-4. Plus (+) sign indicates P-1 group mean value on x-axis plotted against the group mean value of the P-4 on y-axis. Arrow indicates the direction of expected change. Orthogonal line indicates no change.

Observed negative emotionality scale. In Figure 19, it can be seen that the intervention infants tended to display more negativity during free play with their parents than the comparison infants at baseline. Data for the intervention-recipient children showed more variability in NE, while most comparison infants (except for two) did not show any sign of negativity while they were playing with their parent at home. In Phase-2, while infants were experiencing the intervention, they showed an improvement in NE or remained the same (except for 2 infants who had score increases in Phase-2). Only one comparison infant showed a decrease in their NE and others either had no change or changed for worse.

Following Phase-3 the group mean for the intervention infants showed an improvement in NE while comparison infants' group mean showed no change. By Phase-4 the difference between groups became more evident as the phase mean of the intervention infants continued to show improvement, while the mean score of the comparison infants deteriorated. At follow up, all intervention infants had NE scores of one or two, indicative of no to mild levels of negative emotion (except for one infant who had a score of three consistently from Phase-2 onwards). One infant who showed highly negative emotions at Phase-1 immediately improved at Phase-2 and remained improved and infants who had NE score of three at Phase-1 showed a gradual improvement through to Phase-4.

Whereas only two comparison infants had scores of one and one infant with a score of two showed no change at Phase-4, five infants who had no signs of NE at Phase-1 all got worse and showed between slight and high levels of negative emotion during free play at Phase-4. From Phase-1 to Phase-4, the comparison infants' group mean changed to show deterioration in negative emotionality. Thus, the median of Phase-4 frequency of observed negative emotionality scores (see Appendix K for the MBP) for comparison infants (*Mdn* = 6) was higher than the median scores of intervention infants (*Mdn* = 2.5) with a medium to large effect, *U* = 12.500., *p* = .013, *A* = 0.84.

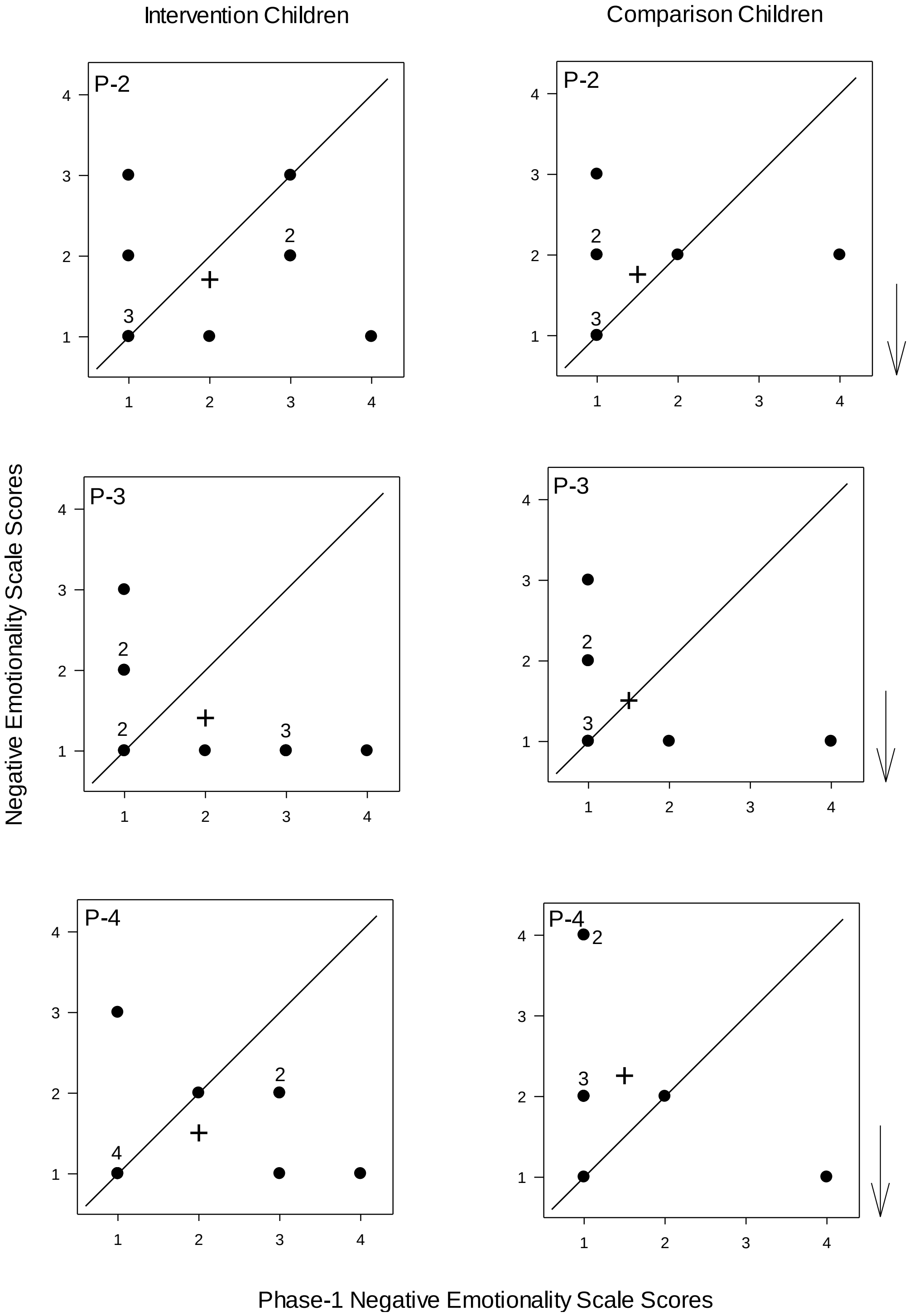

Figure 19. Modified Brinley Plot of Negative Emotionality Scale (1 to 4) for intervention and comparison children.

Note. Individual scores on Phase-1 displayed on x-axis plotted against each individual's scores on following phases displayed on y-axis. P-2 = Phase-2, P-3 = Phase-3, P-4 = Phase-4. Plus (+) sign indicates P-1 group mean value on x-axis plotted against the group mean value of the corresponding phase on y-axis. Arrows on the right side of the plots indicate the direction of improvement. Orthogonal line indicates no change. Numbers on the plot points indicate the number of participants with the exact x and y-axis scores.

Parental cognitions about infant sleep. This section reports MBP plots of the parents' scores on the MCISQ subscales of difficulty with limit setting, anger, doubt, and feeding beliefs (Figures 20, 21, 22, 23). Plots of Safety beliefs and Total score on the MCISQ can be found in Appendix K.

At baseline (P-1) all parents scored similarly on anger, doubt, and feeding subscales with anger and doubt scores towards the lower end of the scale range and feeding beliefs more variable. For difficulty with limit setting, intervention parents had moderate scores across a wide range, whereas comparison parents' limit setting difficulty scores were typically at the higher end of the scale.

Difficulty with limit setting. Following intervention, intervention parents' limit setting difficulty scores immediately decreased, most quite substantially, and more so for parents whose baseline scores were high, while comparison parents' scores showed a much smaller reduction with most scores remaining close to the line of no change. The marked reduction in the median limit setting scores of intervention parents (Phase-1 *Mdn* = 17 to Phase-4 *Mdn* = 6.5) and comparison parents (Phase-1 *Mdn* = 19.5 to Phase-4 *Mdn* = 17) were statistically significantly different over time (Wilcoxon Signed Rank Test for repeated measures; as for intervention parents $Z = -2.530$**,** $p = .011$; for comparison parents $Z = -2.375$ $p = .018$).

Thereafter, during Phase-3 and Phase-4, parents whose infants were treated mostly continued to reduce their scores while the comparison group parents showed little change. The difference between the two groups was also statistically significantly different with a large ES (intervention *Mdn* = 6.5; comparison parents *Mdn* = 17 at Phase-4; $U = 2.000$, $p = .001$, $A = 0.97$).

Anger. In baseline, anger scores for parents in both groups were low to moderate. Scores show little systematic change over time from Phase-2 to Phase-4 for either group. No parent in either group showed a meaningful increase in anger over time, whether experiencing intervention or not (although, the Wilcoxon rank sign test results for within-group change for the intervention parents' median scores from Phase-1 (*Mdn* = 7) to Phase-4 (*Mdn* = 4) was statistically significant, $Z = -2.568$, $p = .010$). In addition, between group differences at Phase-4 median scores (intervention parents *Mdn* = 4 and comparison parents *Mdn* = 7) were statistically significantly different (Mann-Whitney $U = 16.000$, $p = .031$, $A = 0.80$; ES moderate).

Doubt. The pattern shown for changes in doubt over time resemble those for anger, although the range of doubt scores in baseline (P-1) is slightly greater than for anger. Parents experiencing the intervention reduced their doubt scores over time, particularly at Phase-3 and Phase-4, more so for those with high initial scores than with initially low scores. Intervention group parents scores changed statistically significantly from Phase-1 to Phase-4 ($Z = -2.670$, $p = .008$). Comparison parents showed little change in doubt scores over time. Between-group differences at Phase-4 were also significant with a moderate effect ($U = 12.500$, $p = .014$, $A = 0.84$).

Feeding beliefs. In baseline, parents' feeding beliefs covered a wide range for both groups. Changes over time in these beliefs were much more marked for the intervention group parents than for the comparison group, where the mean score hardly shifts from the line of no change over phases. The difference between intervention parents' Phase-1 median score and Phase-4 median score was statistically significant ($Z = -2.807$, $p = .005$) and the difference between Phase-4 median scores of intervention parents and comparison parents was also statistically significant with a moderate effect ($U = 10.500$, $p = .008$, $A = 0.86$).

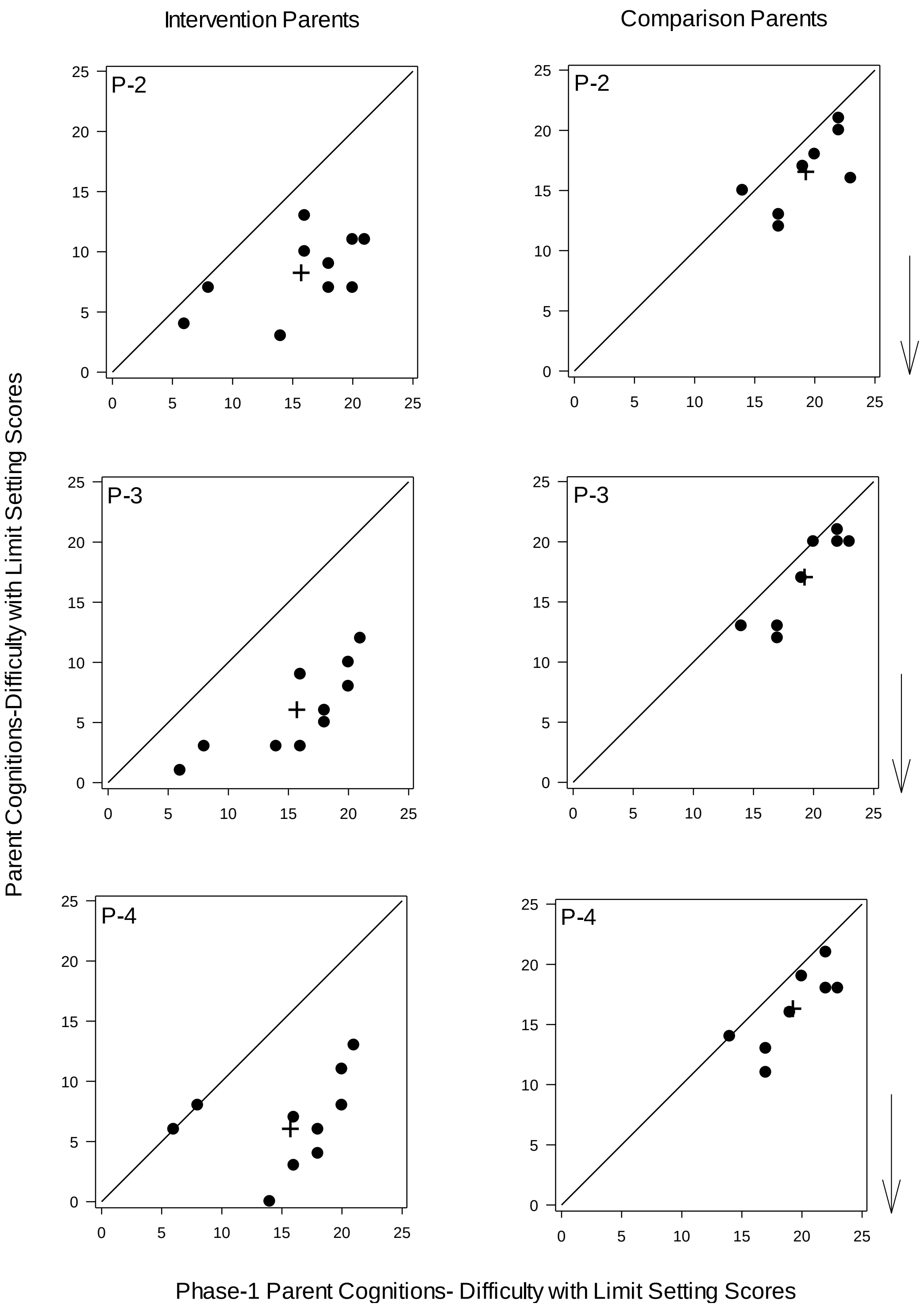

Figure 20. Modified Brinley Plot of Difficulty with Limit Setting subscale scores of MCISQ for intervention and comparison children.

Note. Individual scores on Phase-1 displayed on x-axis plotted against each individual's scores on following phases displayed on y-axis. P-2 = Phase-2, P-3 = Phase-3, P-4 = Phase-4. Plus (+) sign indicates P-1 group mean value on x-axis plotted against the group mean value of the corresponding phase on y-axis. Arrows on the right side of the plots indicate the direction of improvement. Orthogonal line indicates no change.

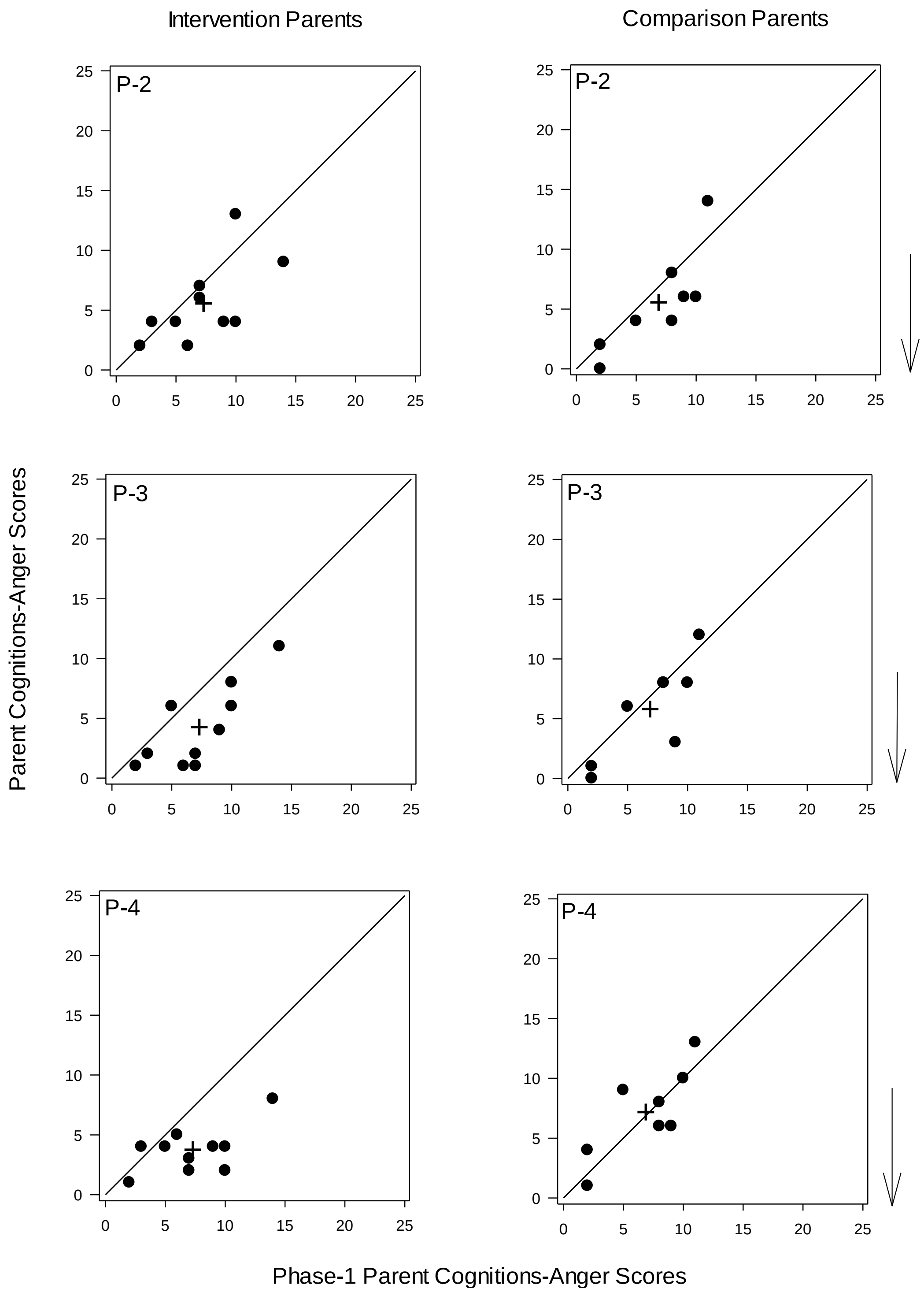

Figure 21. Modified Brinley Plot of Anger subscale scores of MCISQ for intervention and comparison children.

Note. Individual scores on Phase-1 displayed on x-axis plotted against each individual's scores on following phases displayed on y-axis. P-2 = Phase-2, P-3 = Phase-3, P-4 = Phase-4. Plus (+) sign indicates P-1 group mean value on x-axis plotted against the group mean value of the corresponding phase on y-axis. Arrows on the right side of the plots indicate the direction of improvement. Orthogonal line indicates no change.

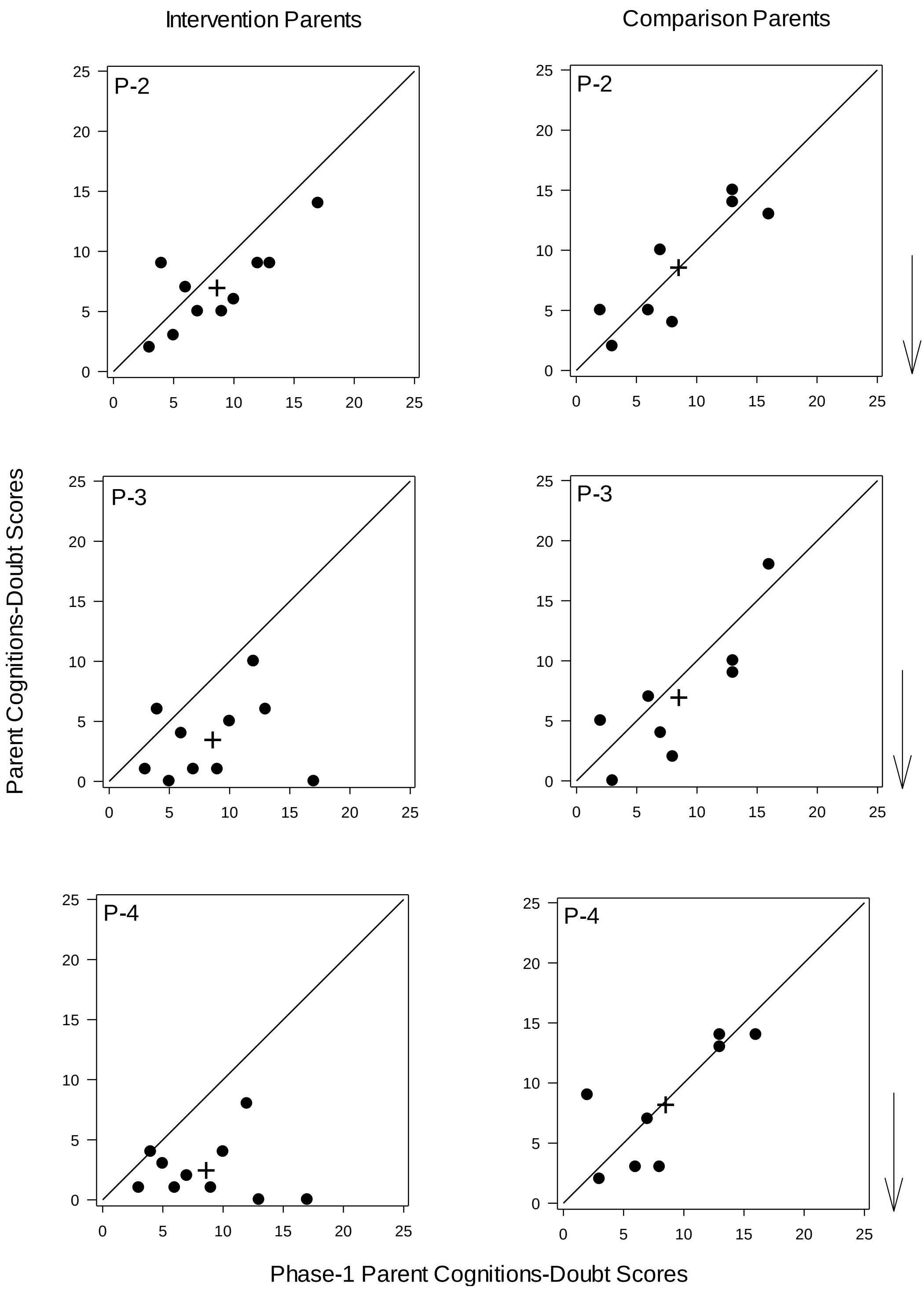

Figure 22. Modified Brinley Plot of Doubt subscale scores of MCISQ for intervention and comparison children.

Note. Individual scores on Phase-1 displayed on x-axis plotted against each individual's scores on following phases displayed on y-axis. P-2 = Phase-2, P-3 = Phase-3, P-4 = Phase-4. Plus (+) sign indicates P-1 group mean value on x-axis plotted against the group mean value of the corresponding phase on y-axis. Arrows on the right side of the plots indicate the direction of improvement. Orthogonal line indicates no change.

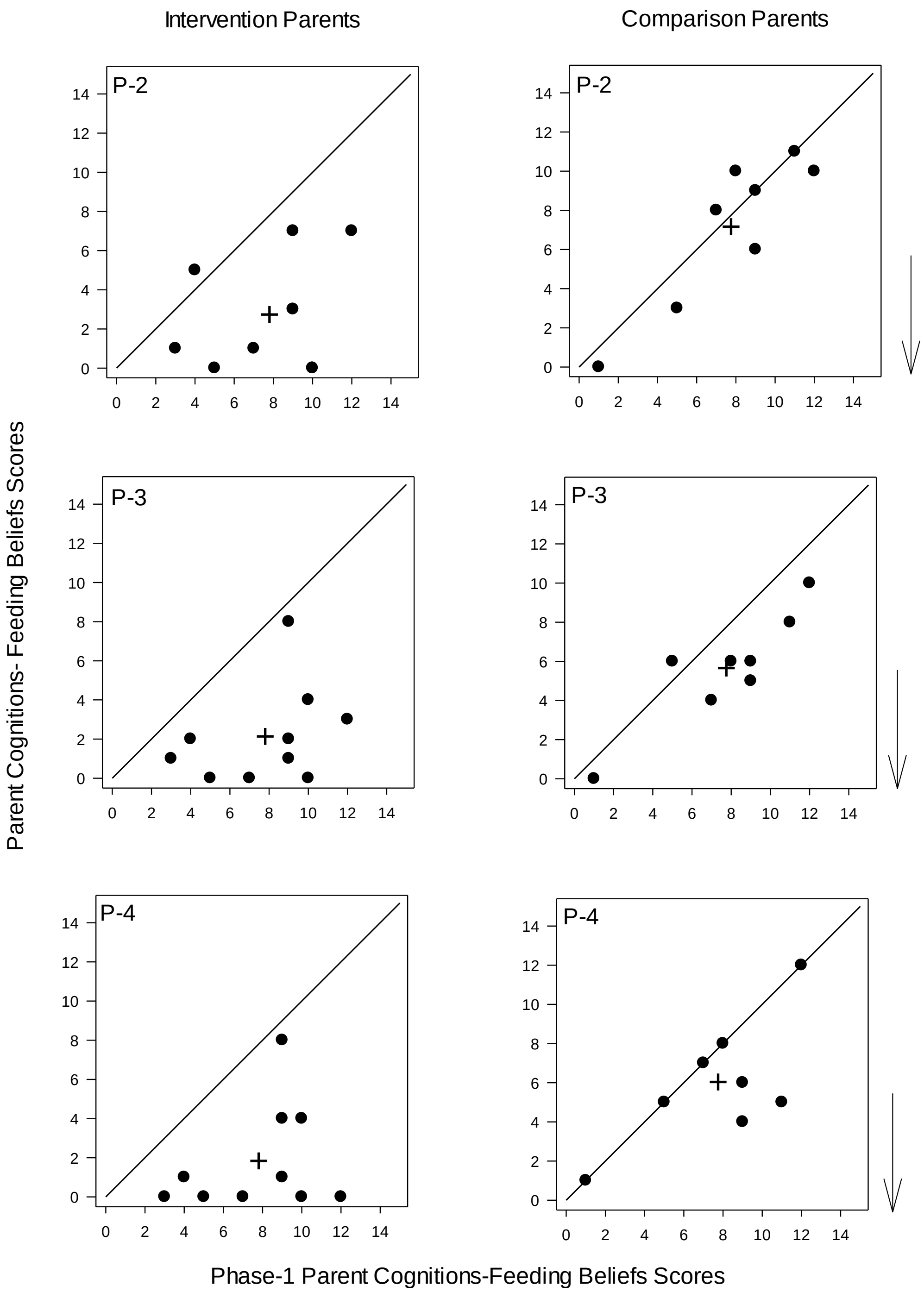

Figure 23. Modified Brinley Plot of Feeding beliefs subscale scores of MCISQ for intervention and comparison children.

Note. Individual scores on Phase-1 displayed on x-axis plotted against each individual's scores on following phases displayed on y-axis. P-2 = Phase-2, P-3 = Phase-3, P-4 = Phase-4. Plus (+) sign indicates P-1 group mean value on x-axis plotted against the group mean value of the corresponding phase on y-axis. Arrows on the right side of the plots indicate the direction of improvement. Orthogonal line indicates no change.

Parental wellbeing. Parental wellbeing was measured using the sub-scales of the DASS-21, i.e., Depression, Anxiety, and Stress; and were plotted below except for Total scores (see Figures 24, 25, 26). For this measure, psychometric information permitted the calculation of the RCI, and this is shown as dashed lines parallel to the line of no change (see Figure 4 for an example on MBP interpretation).

In baseline, only a few parents reported levels of depression, anxiety, or stress that were in the clinical range; most were non-clinical, and this is equally true for parents in both groups (Figure 24). Most of the change in depression, anxiety or stress that occurred over time was within the RCI, and so does not represent either improvement or deterioration. Again, this was true for both groups of parents, importantly, only one parent showed deterioration to clinical levels in any of the domains measured (see Figure 25), but had returned to initial levels (within the RCI) by Phase-4. The median stress scores of intervention parents, however, showed a statistically significant decline from Phase-1 to Phase-4 (Figure 26) (Wilcoxon Sign Rank Test $Z = -2.339$, $p = .019$).

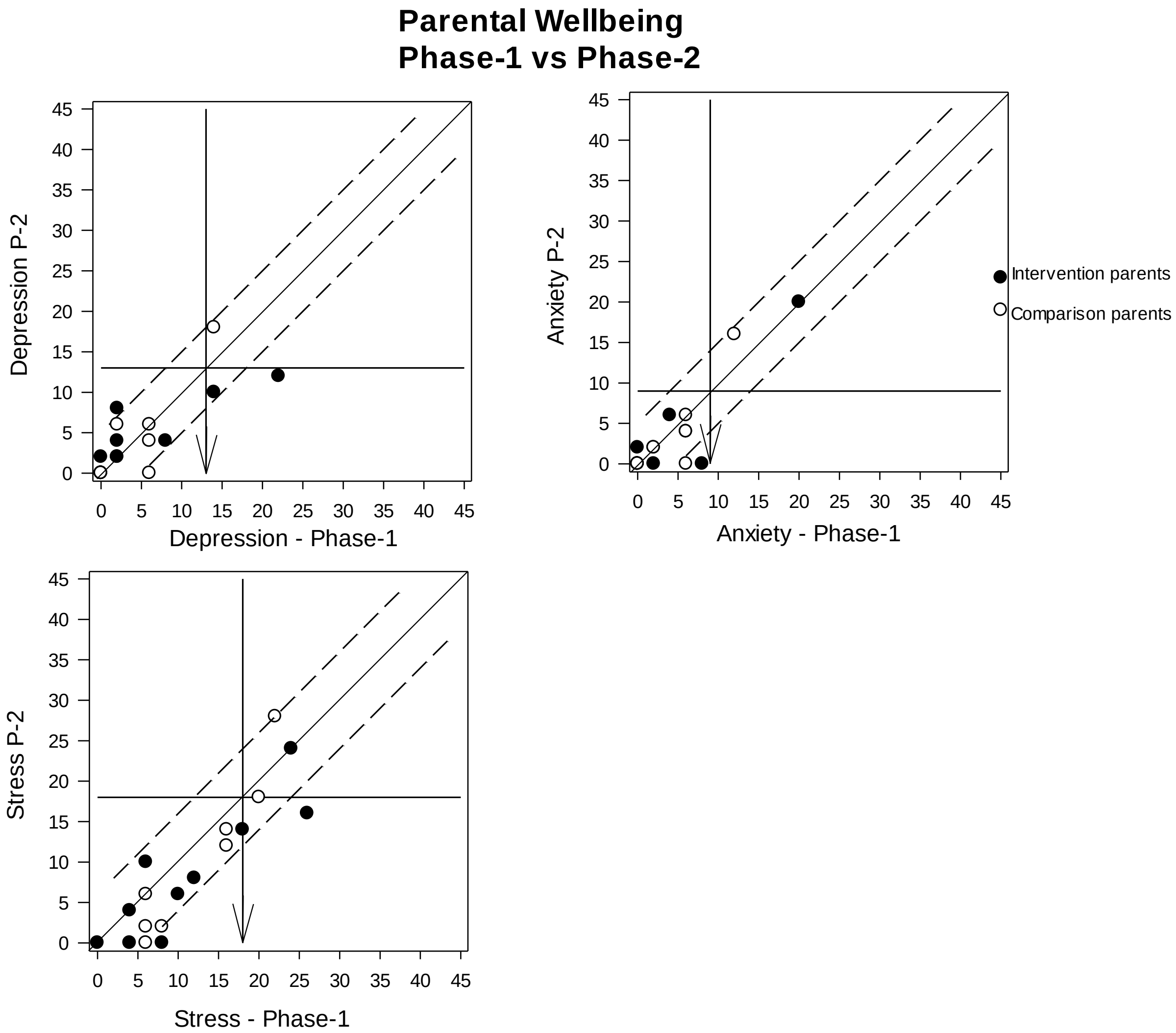

Figure 24. Modified Brinley Plots of the Depression, Anxiety and Stress (DASS-21) scores on each subscale for intervention and comparison children. Individual scores from Phase-1 displayed on x-axis plotted against each individual's scores from Phase-2 displayed.

Note. Open circles show scores of the comparison parents and closed circles show scores of the intervention parents. P-2 = Phase-2. Arrow indicates the direction of improvement. Orthogonal line indicates no change. Dashed lines on each side of the mid line indicate the RCI boundaries. The cut-off scores are 13 for depression, nine for anxiety, and 18 for stress.

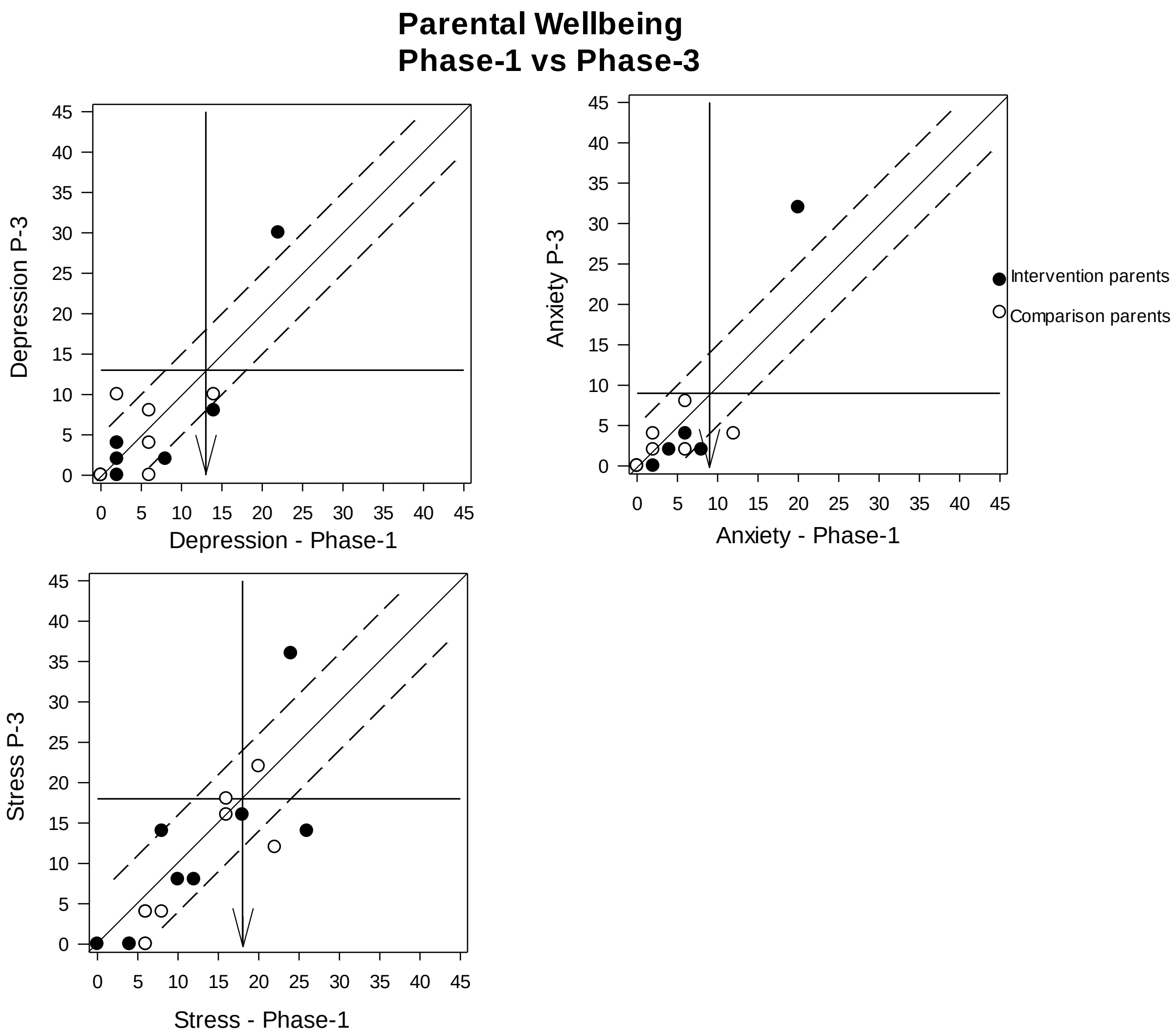

Figure 25. Modified Brinley Plots of the Depression, Anxiety and Stress (DASS-21) scores on each subscale for intervention and comparison children. Individual scores from Phase-1 displayed on x-axis plotted against each individual's scores from Phase-3 displayed.

Note. Open circles show scores of the comparison parents and closed circles show scores of the intervention parents. P-3 = Phase-3. Arrow indicates the direction of improvement. Orthogonal line indicates no change. Dashed lines on each side of the mid line indicate the RCI boundaries. The cut-off scores are 13 for depression, nine for anxiety, and 18 for stress.

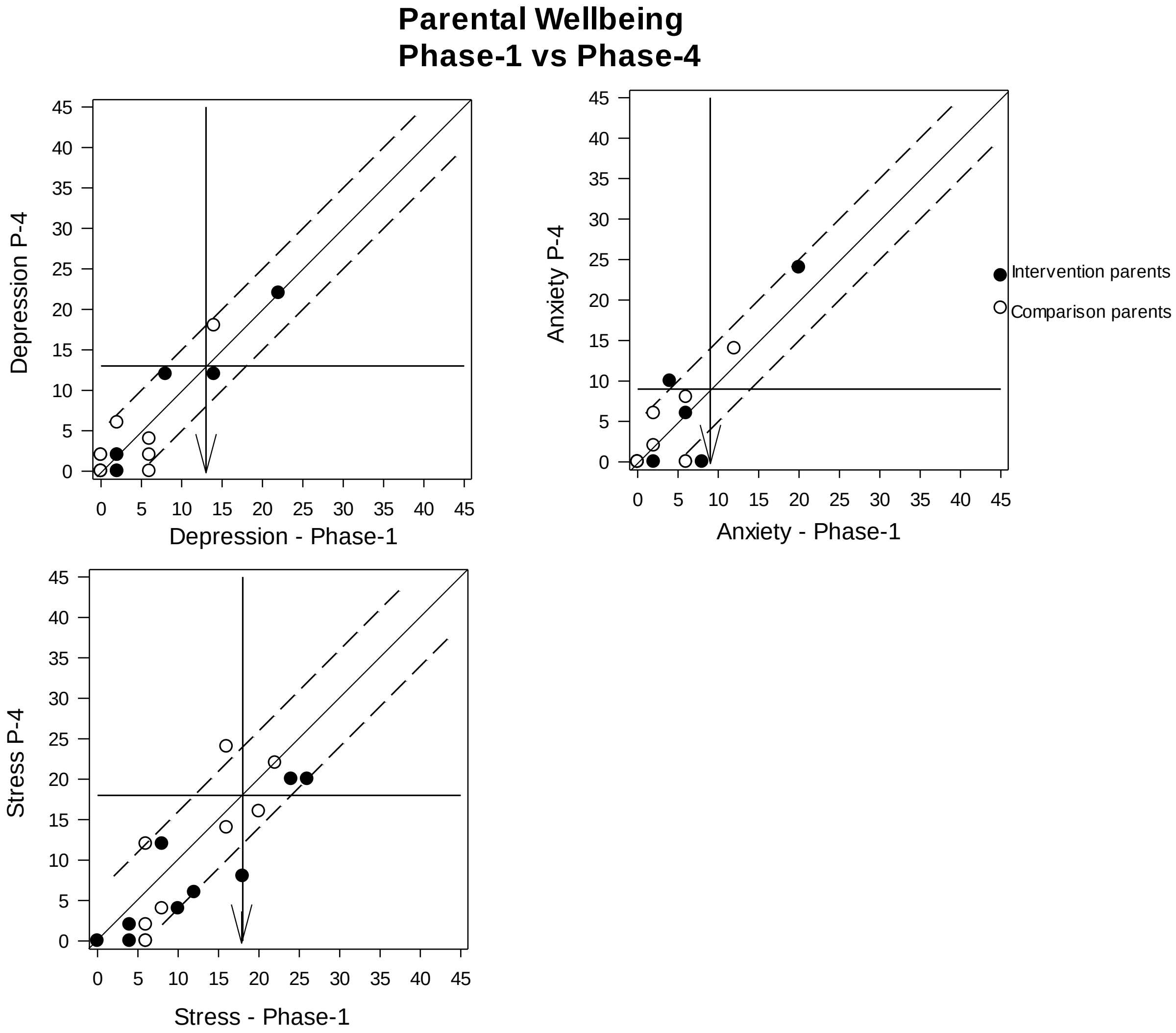

Figure 26. Modified Brinley Plots of the Depression, Anxiety and Stress (DASS-21) scores on each subscale for intervention and comparison children. Individual scores from Phase-1 displayed on x-axis plotted against each individual's scores from Phase-4 displayed.

Note. Open circles show scores of the comparison parents and closed circles show scores of the intervention parents. P-4 = Phase-4. Arrow indicates the direction of improvement. Orthogonal line indicates no change. Dashed lines on each side of the mid line indicate the RCI boundaries. The cut-off scores are 13 for depression, nine for anxiety, and 18 for stress.

Parental daytime sensitivity. Figure 27 displays parental daytime sensitivity scores across all four phases of the study. All parents in the study were coded as highly sensitive using the Mini-Maternal Behaviour-Q-Sort for video coding-revised at Phase-1 and scores of intervention parents remained around the line of no change in each phase. Comparison group parents either showed little to no change or a slight increase in their sensitivity scores, thus, the mean score of the comparison parents moved towards improvement by Phase-4 as two parents' scores improved from less sensitive to highly sensitive.

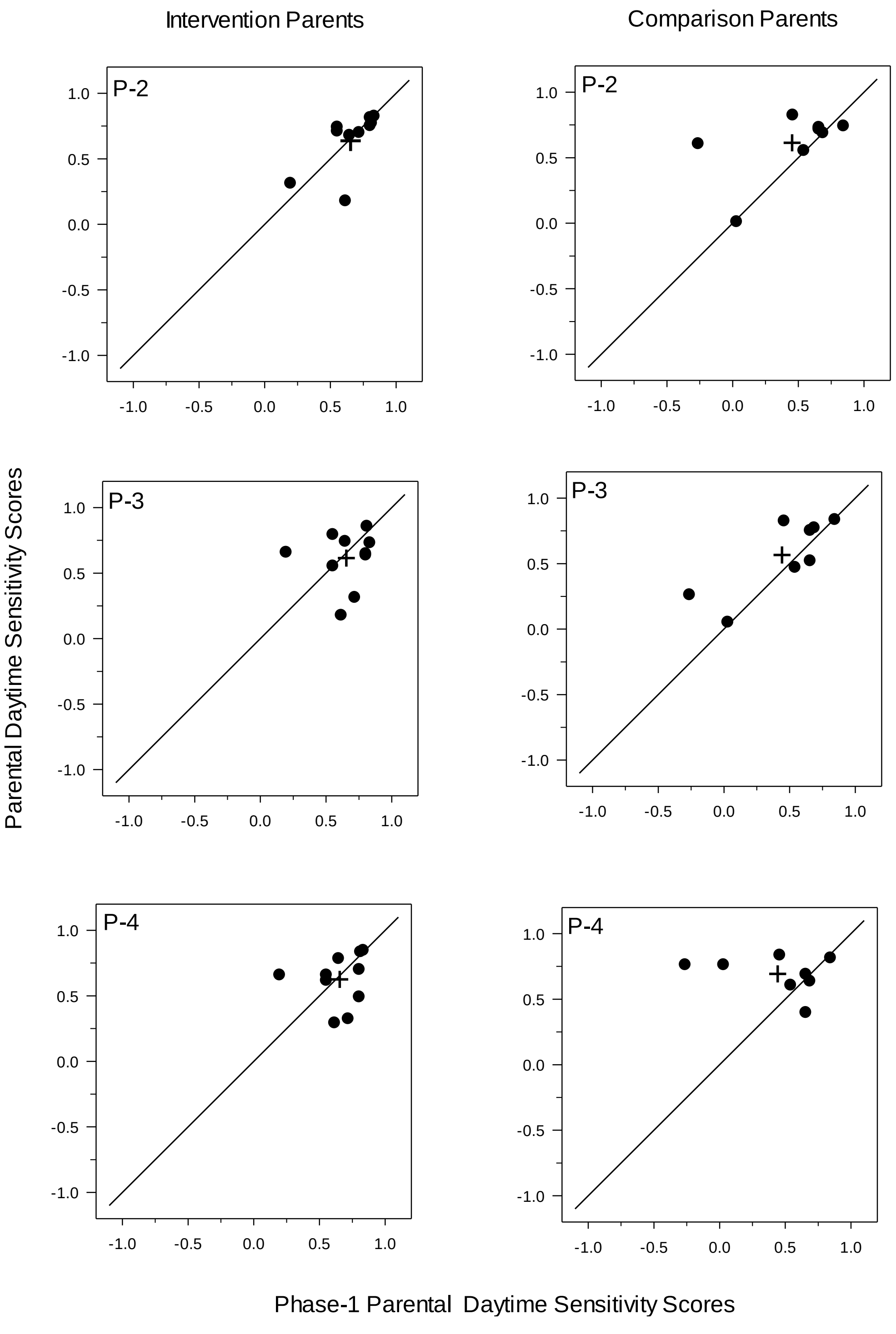

Figure 27. Modified Brinley Plot of Parental Daytime Sensitivity measured by Mini-MBQS-25-v-Revised for intervention and comparison children.

Note. Individual scores on Phase-1 displayed on x-axis plotted against each individual's scores on following phases displayed on y-axis. P-2 = Phase-2, P-3 = Phase-3, P-4 = Phase-4. Plus (+) sign indicates P-1 group mean value on x-axis plotted against the group mean value of the corresponding phase on y-axis. Orthogonal line indicates no change.

Discussion

There were two major aims of this study: (a) to explore the relationship between ISD in 1-year-old infants, the quality of attachment, and secondary infant and parent variables associated with development of both sleep and attachment in the literature and (b) to ascertain whether implementing a BSI has an effect on the quality of attachment or whether the quality of attachment has an effect on the outcomes of a BSI by measuring attachment before and after the intervention. A mixed design of prospective longitudinal pre-test/ post-test and an experimental nonconcurrent single-case design with a multiple baseline across participants was employed to achieve these aims with two groups of families differing in their help-seeking preferences. Having two naturally formed groups allowed the researcher to follow changes in sleep and attachment through time and compare characteristics of these families whose infants have ISD and either want or do not want to implement a BSI.

Overall, findings suggested that to intervene with ISD using effectively implemented BSIs does not harm the quality of infant attachment and, in fact, tends to improve attachment security, decrease infant daytime negative emotionality, potentially improve emotion regulation skills, decrease parental stress and improve parental healthy cognitions about their infants' sleep. Initially, infants in this sample did not have more insecure attachment than the normative distributions suggested in the literature and their attachment security scores did not predict the severity of their ISD, whereas, their parents' help-seeking preferences appeared to be dependent upon the dyad's tolerance for cry and separation. Findings also suggested that, when there was no intervention, infants' day time negative emotionality tended to deteriorate; their separation cry duration did not tend to decrease as developmentally expected; and two infants with secure attachment deteriorated to having an insecure attachment, although, the reasons for this may not be directly related to having ISD. Having a consistent secure attachment through the second year of life, however, seemed to be associated with improvements in the sleep patterns of the comparison children.

As the only up-to-date study to experimentally investigate the effects of BSI on attachment, and possible contributing factors pre- and post- treatment, findings not only replicated findings from previous studies but also provided novel contributions to the literature. Results replicate previous studies' outcomes on both primary and secondary effects of BSIs and provide new evidence for its positive influence on the infant attachment and objective negative emotionality. This is also the first study to show characteristic differences between families who are and are not willing to implement a BSI which may have an influence in their help-seeking preferences.

No evidence for a direct relationship between ISD and attachment insecurity is also replicated in this study within the cross-sectional findings, providing further support for the extended 4th theoretical model, which may suggest that infant sleep and attachment security are products of other contributing factors such as infant temperamental biases, parental characteristics, behaviours and cognitions. However, findings from the longitudinal data seem to provide evidence for the negative effects of ISD on infants' wellbeing.

Following the change in sleep and attachment through time provides some support for the theoretical suggestion deducted from the previous literature that the attachment pattern of a 1-year-old may determine the trajectory of their sleep in toddlerhood. Moreover, this study's result on the effect of BSI on infants with insecure attachment suggested an implication, which was not articulated before, that is, insecure infants with ISD may potentially benefit more from a successfully implemented BSI. Further investigation is needed to test the generalisability of these implications.

In what follows, results from the three levels of analysis of this study which are: (a) characteristics of the sample and comparison of two groups of families at baseline; (b) the effectiveness of BSIs and change in sleep through time; and (c) changes in attachment and secondary variables, as a function of intervention or time, across phases and within/across participants are detailed, compared with the findings of previous literature, and possible implications are discussed.

Attachment Patterns of Infants with ISD

At baseline, the distribution of organised attachment patterns corresponded to the universally suggested distributions (Mesman et al., 2016; van IJzendoorn & Kroonenberg, 1988) where most of the infants, 71% in the larger sample and 83% in the smaller sample, had a secure attachment pattern. This characteristic of infants with ISD in this sample indicates that although 75% of the sample experienced severe sleep problems, based on objective criteria, the majority also had a secure relationship with their mothers. Almost half of the infants with a secure pattern also comprised the B4 sub-category which is characterised by relatively higher scores on resistant behaviours and long durations of cry at SSP separation episodes. This tendency in the sample goes in line with Scher (2001a)'s findings of more bedtime difficulties reported by parents of infants with B and B4 attachment patterns, and Bélanger et al. (2015)'s finding that higher dependency predicted shorter nighttime sleep duration. However, sleep problem scores were not higher for infants with B4 attachment. At first glance, the distribution of the attachment patterns in this sample, seem to go in line with the Keller's (2011) 1st model which was first outlined by Sadeh and Anders (1993). Frequent night wakings and calling out for parental assistance may be a manifestation of the attachment system for this sample of infants who were older than 12 months. Nevertheless, this may also be a sampling bias as families were recruited mostly through social media and the majority represented well-educated, middle SES, low risk families.

Predicting Group Membership of Intervention and Comparison Families

When two groups of families were compared for their measured characteristics at Phase-1, two variables, difficulty with limit setting at bedtime and cry durations at SSP separation episodes, were prominent in differentiating the members of these groups with 87.5% success rate. Parents in this study who wanted to receive a BSI found it less challenging to set limits around bedtime and nighttime to their infants, and their infants were less overtly distressed when they experienced a short separation from their parent, although MBP of cry durations at SSP reveal a more homogenous pattern for comparison infants' data (towards the upper limit) and more variable pattern for intervention infants' data. Although there were some studies exploring parental perspectives on implementing BSIs (for example, Blunden & Baills, 2013) and frequency of parental help-seeking in ISD (Morrell, 1999b), in addition to France's (1992) finding, this is the first study to indicate a difference based on an objective measure in the characteristics of those infants with ISD whose parents do not want to implement BSI.

It may be that this finding might give a further insight into why some parents may find BSIs more practical and already employ these without professional support (Honaker, Schwichtenberg, Kreps, & Mindell, 2018) and some may be more reluctant and feel the need to look for alternatives (Etherton et al., 2016). Thomas (2006) suggested that one of the important factors for therapeutic change is the match between world view and expectations of the client and the provided model or technique. Although there was one study (Middlemiss, Stevens, Ridgway, McDonald, & Koussa, 2017) to test the effectiveness of a sleep intervention, suggested to be an alternative to BSIs, more evidence-based alternative approaches are needed for families who want to receive help for their infants' sleep but who would like to be more flexible with limit setting at nighttime because their infants express overt separation distress.

Factors Associated with ISD and Attachment Security

There were a limited number of factors associated with sleep and attachment variables at Phase-1 of this study. Most factors that are repeatedly suggested to predict ISD and attachment security, such as perceived negative emotionality or parental mood, were not found to be associated with the variables of this study. The most important factor associated with ISD was the intensity of the parental nighttime involvement which was measured by the Bedtime Soothing Scale (Tikotzky & Sadeh, 2009) for both the larger (*n* =24) and the smaller sample (*n* = 18), followed by more concerns around the infants' hunger at night (MCISQ Feeding subscale), less negative emotionality during free play, and difficulty with limit setting at nighttime (MCISQ Limit Setting subscale) for the larger sample; and less attachment resistance behaviour, less negative emotionality during free play, and more difficulty with limit setting at nighttime for the smaller sample. Except for less resistance and negative emotionality, these associations were partially in line with the suggestions of the transactional and behavioural models of ISD (France & Blampied, 1999; Sadeh et al., 2010).

Based on previous literature, it was unexpected to find infant attachment resistance and negative emotionality scores to be negatively associated with the severity of sleep problem scores of the smaller sample. Aside from the small simple size, this finding might be related to some parents' practice of intentional cosleeping and not seeking professional help. Literature on intentional cosleeping reports that it usually begins early in infancy and although these infants are reported to have higher frequency of night wakings, their parents tend to have a more neutral perspective on their infants' sleep pattern than the ones who practice reactive cosleeping (Messmer et al., 2012). In New Zealand, the reported average prevalence of cosleeping is 12.5% without the information on intentions (Mileva-Seitz, Bakermans-Kranenburg, Battaini, & Luijk, 2017). In this sample, therefore, cosleeping is overrepresented, especially in the smaller sample with one in five parents practicing intentional cosleeping. In addition, France (1992) reported that parents of infants with ISD who did not seek help rated their infants as temperamentally more likeable, agreeable and less emotional and tense than parents of infants with ISD who sought help. She suggested that these infants' sleep problems may seem more tolerable to their parents or these parents may be more relaxed and accepting that their ratings are more favourable. Interestingly, there were no differences in perceived negative emotionality of infants in the two groups of this study. It may be that there were other differences in their temperamental biases that the fussy/difficult temperament measure (ICQ) failed to capture.

Effectiveness of BSIs and Change in Sleep through Time

The visual analysis of the sleep patterns within and across infants who received intervention revealed that the sleep patterns at baseline were stable and improvements occurred when and only when intervention was introduced. Thus, BSIs used in this study were moderate to highly effective at reducing sleep problems of all intervention infants with eight of them showing no further problems at follow up. This finding provided further support for the effectiveness of BSIs in reducing sleep problems in infants and toddlers. The success was partially owing to the 'Guided Participation Model' (Sanders & Burke, 2014) used to produce tailored programs for each participating family's needs and also providing ongoing professional support during the intervention phase which was articulated by parents as the most helpful part of the program. Because of the individualised nature of each intervention, the most effective modification of an extinction program cannot be identified. Another and perhaps, the most important reason for intervention success was, despite frequent sicknesses, most parents consistently implemented the agreed plan of the intervention. Therefore, except for some disruptions, the improvements were maintained through follow up. As expected, the intensity of intervention parents' nighttime involvement also dropped dramatically through the intervention phase and consistently remained low.

Interestingly, comparison infants' sleep patterns, although stable at baseline, showed a gradual improvement through time while most of their parents' nighttime involvement remained the same. Change in sleep patterns through time is expected based on findings from studies on both normal development of sleep (Ohayon et al., 2017) and changes in ISD from infancy to childhood (Kocevska et al., 2017). At follow up, however, they were all still defined as having ISD based on objective criteria. Therefore, the data from this study show that intervening with infants' sleep dramatically improves what may be a 'natural' rate of change, with deterioration a risk in some cases.

Change in Secondary Variables after Receiving a BSI or Through Time

Infant level. The two objective negative emotionality measures used in this study, the 4-point scale of NE during free play and cry durations at SSP separation episodes, indicated an improvement in intervention infants and a slight deterioration in comparison infants from Phase -1 to Phase-4. The improvement in intervention infants can be considered a further demonstration of the generalised benefits of the effective BSIs and deterioration through time for comparison infants might be one of the negative effects of having persistent sleep problems. The aim of using these measures was to capture a specific aspect of infant temperamental bias, however, these were not correlated with perceived negative emotionality as measured by ICQ and they were not correlated with each other as well, except for those generated from the same observational data. Therefore, it is not conclusive whether these measures captured a change in negative emotionality as a temperamental bias, as intended, or indicate another important aspect of infant development, perhaps emotion regulation skills.

Emotion regulation is defined as a process in physiological, behavioural and cognitive levels to modulate the experience and expression of negative and positive emotions (Gross, 1998) and it is important for children's socio-emotional and relational development (Gross & Thomson, 2007). There are studies looking at the effect of sleep on emotion regulation skills and the relationship between the security of attachment and variations in infants' emotion regulation skills, although there seems to be no consensus on the construct measured in these studies (Braungart & Stifter, 1991; Kim, Stifter, Philbrook, & Teti, 2014; Palmer & Alfano, 2017; Riva Crugnola et al., 2011; Williams et al., 2016). Nevertheless, what was measured in NE Scale and cry durations at SSP separation episodes in this study and the definitions used in emotion regulation studies in both the sleep and attachment fields seem to overlap.

Williams et al. (2016) in their study on the effects of infant sleep problems on emotion regulation skills and later behavioural problems, defined emotion regulation for infancy, using the items of the Australian Temperament Scales (Prior, Sanson, & Oberklaid, 1989), as following: "the baby is fretful on waking up and or going to sleep (frowns, cries, reversed item); baby amuses self for 30 minutes or more in cot or playpen; baby continues to cry in spite of several minutes of soothing (reversed item)"; and for toddlers as following: "child cries when left to play alone (reversed item); child responds to frustration intensely screams and yells (reversed item); child has moody off days when the child is irritable (reversed item)." (p. 336). These items are quite similar to how negative emotionality was defined in this study and the criteria items used during the coding of observations, except that an objective measure was used in this study. In their study, persistence of sleep problems and emotion dysregulation were associated in 31% of the participants who also displayed behavioural problems in childhood. The NE Scale in the present study, which measured the observed negativity of the infant during a free play session with the parent, was found to be negatively associated with the severity of sleep problems at baseline which contradicts with findings from both Williams et al. (2016)'s and the original study which this measure was adapted from (Troxel et al., 2013). This was probably related to the lower scores of the comparison infants, as discussed above, and having a free play session rather than a structured one with a frustration task as they had for older infants in the NICHD study.

However, the deterioration in the scores of comparison infants from Phase -1 to Phase-4 seems to go in line with suggestions of Williams et al. (2016) on the implications of their findings. Although early onset ISD and self-regulation may be genetically determined, persistent ISD may increase the likelihood of having poorer self-regulation skills in later childhood through this affecting neurological responses and processes. Indeed, a recent study found a deterioration in grey matter in the brains of children who had sleep problems since infancy (Kocevska et al., 2017). To our knowledge, there has been no study to investigate emotion regulation skills of infants with ISD using an objective measure. Perhaps the NE Scale, combined with the frequency of observed NE behaviours, could be validated against a parental report emotion regulation measure which may increase its sensitivity as a potential objective measure for emotion regulation skills.

The emotion regulation skills and attachment patterns were investigated in several studies by assessing the reactions of infants during the Strange Situation Procedure by comparing the pre-separation, separation, and reunion episodes (Braungart & Stifter, 1991; Thompson & Lamb, 1984). A recent study by Riva Crugnola et al. (2011) observed and coded hetero-regulatory, such as positive and negative social engagement towards the mother and the stranger, object-oriented regulatory, self-comforting regulatory, self-vocalisation and mother-searching behaviours in 15-seconds intervals. They categorised “crying when alone”, which is partially the cry duration at SSP separation episodes, within the “failure to regulate emotions” group along with autonomic stress indicators and disorganisation. It was found that infants with different attachment patterns (A, B, and C specifically) displayed different emotion regulation strategies when faced with the mild stress of the SSP. However, no differences were found in their separation cry durations. In addition, although they were equally upset during the separation episodes, secure infants were able to use a variety of strategies including the more mature ones such as searching for the mother or using self-vocalisation to calm themselves down when both adults were absent while they continued having a more positive attitude toward the parent throughout the procedure.

In the present study, the cry durations at SSP separation episodes were already different for intervention and comparison infants while the distribution of their attachment patterns was quite similar. At Phase-4 however, the difference had become even more apparent as intervention infants showed a decline and comparison infants did not. The change in the duration of cry at SSP separation episodes for intervention infants was an interesting finding when it is considered as an indicator of “failure to regulate emotions”. Yang (2016) suggested that implementing BSIs in a consistent and predictable way may contribute to the development of resilience in children by providing the opportunity to develop self-soothing skills through exposure to tolerable stress, which is a type of stress suggested to be crucial for the development of self-regulation and executive functioning (Center on the Developing Child at Harvard University, 2015). Therefore, the decrease in separation cry durations of intervention infants may indicate a change in their repertoire of behaviours to cope with a tolerable stress. As most infants in both groups were categorised as secure at both assessments and all attachment categories were not represented equally owing to the sample size, it is difficult to make any further inferences. A longitudinal investigation on how BSI might affect emotion regulation strategies of infants with different attachment patterns using the SSP could shed further light on the effects of sleep quality on emotion regulation skills as moderated by the security of attachment.

Parent level. From Phase-1 to Phase-4, parents who implemented the intervention experienced a dramatic change in their cognitions about their infants’ sleep, towards less difficulty with limit setting at nighttime, less anger about their infants’ sleep, less or almost no doubt about how they manage their infants’ sleep and less worry about their infants’ hunger (feeding) at nighttime. This may indicate that, although these variables were not the primary focus of the intervention, a generalised and beneficial change was observed concurrent with the targeted change in sleep. Similar findings about the change in parent cognitions were previously reported in the literature (Hall et al., 2006), therefore, this finding supports Sadeh et al. (2010)'s suggestion that cognitions of parents around their infants' sleep may be one of the most important factors associated with ISD. In contrast to these changes observed in intervention parents, comparison parents' cognitions about their infants' sleep did not show much change. Some parents articulated an incongruence between their parenting view and some of the items in the MCISQ and therefore this questionnaire may not have reflected their cognitions as accurately.

Another decline was detected from Phase-1 to Phase-4 in DASS-21 Stress scores of parents who implemented the intervention. Parents in this sample generally did not show symptoms of depression, anxiety or stress in clinical levels except for one parent in the intervention group and their scores showed consistency through four phases of the study. Change in parental stress for the intervention group was another indication that implementing the intervention, unlike Etherton et al. (2016) claimed, did not increase stress levels of parents and in fact helped its improvement in the long term. The most difficult part of implementing a BSI is the first week of the program for most parents and this has been previously addressed in intervention studies (Črnčec et al., 2010; France & Blampied, 2005; Loutzenhiser, Hoffman, & Beatch, 2014). Therefore providing a consistent, full time professional support especially during the first week, as was followed in this study, is recommended as the best practice (Byars & Simon, 2016; France et al., 1996; Morgenthaler et al., 2006).

Change in Attachment Variables after Receiving a BSI or Through Time

The Strange Situation Procedure was replicated four to six months after the first day of Phase-1 and the comparison of findings revealed that attachment security as a continuous score and attachment patterns with ABC coding changed for both groups in opposite directions. Intervention infants' attachment changed towards secure as all secure infants remained secure and one insecure infant moved to secure and even the infant with insecure attachment showed an improvement in attachment security scores. This finding is the first in the literature to show that, in this sample, behavioural interventions for 1-year-old infants' sleep did not disrupt the attachment relationship and even tended to improve the pattern.

As time passes children's behaviours observed in SSP tend to change as well and the classification criteria are also adapted for toddlers. Children tend to show less strong proximity seeking and contact maintenance behaviours around 18 months when compared to 12 months and the classification into secure or insecure sub-categories are informed from those developmental considerations (Schneider-Rosen, 1990). Owing to this natural decrease in scores given to each interactive behaviour scale (including the attachment resistance score, hence it was not plotted), a reduction in these modified Richters' scores, which is essentially a DFA prediction formula generated using the interactive attachment behaviours scores (Belsky, Campbell, Cohn, & Moore, 1996; Richters et al., 1988; van IJzendoorn & Kroonenberg, 1990), is theoretically expected. This natural decline was slightly observed in comparison infants' scores except for the dramatic change observed in the scores of three infants. The overall improvement in attachment security scores of intervention infants is, therefore, unexpected.

The interpretation of the improvement in intervention infants' attachment security needs consideration of changes in other contributing factors as well. As described above, following the introduction of a sleep intervention, infants' sleep patterns improved dramatically as they rarely woke up for shorter durations and slept longer during the night and concurrently their observed negative emotionality tended to reduce and they cried less when shortly separated from their parents at follow up. Simultaneously, their parents became more confident with and less worried about how they managed their infants' sleep as their physical involvement at nighttime and stress levels tended to decrease while their perception of their infants' negative emotionality, low level of depression and anxiety, and daytime sensitivity tended to remain consistent. Since attachment security and the severity of sleep problems were not associated before intervention, the overall improvement in family wellbeing seems to be a more plausible explanation. A larger sample and taking variables such as the quality of marital relationship and parent sleep (Hall et al., 2006) into account could enhance the understanding of these mechanisms.

In contrast, comparison infants' attachment scores changed towards insecure as two infants with a secure pattern moved to an insecure pattern. Two comparison infants turning from secure to insecure in 4 to 6 months was an alarming finding of this study. In order to discuss whether this may indicate that persistent ISD may have a negative effect on the attachment pattern, first and foremost, there needs to be a larger sample. Nevertheless, a closer look to the individual data is still needed. It seems that both infants were among the ones who did not show a deterioration in their sleep and no other measured variable indicated a dramatic change for comparison infants and parents from Phase-1 to Phase-4. Change in attachment from secure to insecure may be related to some other changes in the family context which are not explored in this study but previously suggested as natural causes for change in attachment, such as an increase in familial or economic distress (Sroufe et al., 2005).

The Effect of Attachment Security on Changes in Sleep

A closer look at the historical and concurrent influence of attachment security on parental involvement at nighttime and changes in severity of sleep problems from Phase-1 to Phase-4 has indicated an interesting finding. It was found that most of the improvement in the severity of sleep problem scores for comparison infants could be explained by consistently having secure attachment (both at Phase-1 and Phase-4). Further, their parents tended to decrease their involvement at nighttime as well. A similar finding was reported by Morrell and Steele (2003) as infants with persistent ISD tended to have insecure attachment. For intervention infants, the ones with insecure attachment at Phase-1 showed more improvement in their sleep pattern from Phase-1 to Phase-4. Although these findings seem to be comparable to the suggested mechanism of secure attachment as a protective factor (Thompson, 2008) and the suggestions of differential susceptibility paradigm on the enhanced effectiveness of interventions for insecure infants (B. J. Ellis et al., 2011), this is a very small sample to make sound interpretations. Future studies with equal representation of each attachment pattern are needed. Nevertheless, it can be confidently claimed that secure attachment is not predictive of initial sleep problems, nor of response to treatment.

Strengths of the Study

As introduced in the rationale of this study, previous literature had shortcomings that needed to be addressed. In this study, most of these issues were addressed as following: (a) most of the contributing factors in infant and parent domains affecting both sleep and attachment development were measured; (b) the sample consisted of infants with ISD based on both maternal and objective criteria; (c) both objective and subjective measures were used to assess sleep and other contributing factors. In particular, negative emotionality was triangulated with two objective and one subjective measure; (d) both continuous and categorical attachment variables were assessed with the gold standard measure at two time points; and (e) having a comparison group has allowed to follow changes longitudinally in both sleep and attachment through time.

Although the design selection of this study was partially owing to the limited resources, having a single case research design allowed the collection of time-series data on sleep, combined with a pre-test post-test longitudinal approach allowing collection of point-per-phase data at each phase. This enhanced the richness of data presented and enabled the demonstration of changes in sleep, attachment and other contributing factors through time in a way that has not been done before. Specifically, using the modified Brinley Plots, which allow the visual analysis of changes in point-per-phase variables, while also enabling researchers to report and demonstrate other statistical procedures, made a unique contribution to making the most of this small sample size. MBPs are gradually becoming popular in intervention research and the revival of this rather old technique should be encouraged.

Overall this study's design can be considered a good example of integrated idiographic and nomothetic research principles through which the researcher provided detailed information that is needed for enhancing clinical understanding of the characteristics of families with an infant experiencing sleep problems and primary and secondary outcomes of behavioural sleep interventions.

Limitations of the Study

As this is a project with time and resource restrictions, there were limitations owing to the sampling, measurement, and blinding issues. The sample size initially aimed for was not achieved and the recruitment phase had to be terminated before reaching the target number in each group. The main reason for not being able to reach the target number was the age restriction. This was necessary as infants needed to be within the upper age limit of the SSP at the time of the recruitment for this assessment to be replicated at least 4 months after the first one. Consequently, the initial number of families available was not high enough to guarantee a higher number of participants to remain after attrition. Therefore, generalisation of the findings from descriptive and exploratory analysis is not possible. On the other hand, having 10 intervention infants is sufficient for a strong quality single case research (Cooper et al., 2007) because the experiment was replicated 10 times with similar outcomes and each experiment had two follow up phases to determine whether the behaviour change was maintained. It is important to note that, despite the small sample size, most of the findings discussed above demonstrated moderate to large effect sizes which is an indication of a boutique but powerful design. Further caution should be taken when comparing the results from two groups in this study as ‘comparison’ and ‘intervention’ groups were not matched for age and gender. Since the inclusion criteria was very strict, data collection was proceeded with all potential participants without considering age and gender matching. Therefore these two groups cannot be considered as case-control but rather as parallel observations.

The other limitation about sampling was the demographics of the sample. Findings from this study should be taken cautiously as this was conducted with a very homogenous group of middle class, intact, stable families with very low risk indications, thus, this sample did not represent the whole NZ population. The findings, for example, should not be applied by professionals who work with welfare or other clinical populations. However, this can also be interpreted as a strength rather than a limitation of this study because the intervention outcomes were replicated in each case and there were no major confounding variables, such as a developmental delay or a maternal clinical level health problem, to potentially affect the data.

The data collection and literature search phases had some limitations. First, the VSG data were not available for some families for reasons such as not receiving consent owing to bed-sharing and technical problems experienced throughout the study. Therefore the reliability of sleep diary data from these families could not be calculated. Second, the researcher was unable to locate any previous studies with data collected with an attachment measure in New Zealand to provide the normative distribution of attachment patterns in this population. Nevertheless, there was information in two studies on the attachment patterns of Australian infants and also the worldwide distributions which was considered enough to make a narrative comparison.

Parent and infant daytime variables were obtained through a video recording of their free play interaction and two different assessment tools had to be utilised in order to capture the elements of both sides in the interaction. The parent and the infant within the context of an interaction and each individual's behaviours cannot be considered independent from each other, however, there were no associations between negative emotionality and parental daytime sensitivity measures in this sample. In addition to this, there was a ceiling effect in parental sensitivity for both groups. This could be either because parents in this sample were highly sensitive to their infants' cues, which is quite possible, or perhaps this was owing to the measure and the instructions used. Employing a Q-Set measure was considered as it was readily available. The Mini-Maternal Behavior-Q-Set-V-Revised was, however, chosen to optimise the time management for the data collection phase with the expense of losing the rich information may have been obtained from the original 90-item version of the Maternal Behavior Q-Set. One possibility is that the items were not sensitive enough to identify fine details in the quality of parents' interactions with their infants. Another explanation may be that free play was not the optimal setting to provide finer details on parental sensitivity. Future studies may use natural home-observation, for longer durations, and with different instructions to the parents.

Lastly, blinding was limited for the observational assessments used in this study. The researcher could not be blind to the group allocation and assessment results of the SSP, parental sensitivity and infant negative emotionality. In order to control this bias, coding of observational measures were conducted at least three months after the last assessment of the participant. In addition, blinding was possible for inter-rater reliability coding of all these assessments.

Future Directions

Although this study made a unique contribution to understanding the effects of behavioural sleep interventions on the parent-infant relationship, some of the small but interesting findings need further investigation. Therefore, it would be valuable to have a systematic replication of this study, or a randomized controlled trial, with a larger sample size including problem and non-problem control groups, and using rigorous assessment tools. Having enough representation in each attachment category is necessary to understand the effects of BSIs for each attachment pattern. In addition, this study did not include disorganised attachment pattern as the sample was too small for interpretation of the results with more than three categories. Therefore, a study with a large enough sample to include the analysis of disorganised attachment pattern would be essential. In addition, factors such as marital satisfaction, parental fatigue and sleep quality, and parents' own separation anxiety which may influence or be influenced from sleep and attachment could be included as possible contributing factors. An interactional measure which considers both infant and parent contribution, such as the CARE-Index (Crittenden, 2005) or nighttime Emotional Availability (Teti et al., 2010), is also needed.

What emerges from results of this study is that there seems to be a gap in understanding the effects of ISD, if any, on both the development of attachment security and emotion regulation skills and whether infants with two different developmental trajectories of sleep have differences in their emotion regulation skills in later childhood. As these questions urge the researchers to follow many aspects of infants and parents' characteristics, behaviours, and cognitions, a prospective longitudinal design with multiple time points would be necessary.

A clinical replication, that is, replication using assessment tools which may be readily available or easy to use for clinical purposes would be useful as well. For this replication attachment and maternal sensitivity could be measured with Q-Set materials right after a home observation. It is a fact that attrition rate is high in both clinics providing behavioural sleep interventions and intervention studies (Sadeh & Mindell, 2016) as consistency with implementing the program can be challenging for some parents. In order to increase both parental compliance and retention rate, a clinical guide to using the principles of a guided participation model (Sanders & Burke, 2014) process in clinical sleep practice could be developed. A flow-chart type guide may cover the joint clinician/parent selections of evidence-based sleep interventions along with appropriate stimulus control techniques to help both clinician and the parent to decide which technique and program would suit their current needs.

Conclusion

This study, by using a rigorous, mixed research design, provided detailed analysis of the effects of behavioural sleep interventions on infant attachment security and contributed to the exploration of the relationship between infant sleep and attachment. It can be concluded that behavioural sleep interventions did not cause any harm to the infant, parent, and their attachment relationship. In fact, they improved both sleep and overall family wellbeing. This leads to the conclusion that intervening rather than not intervening seems to have more positive effects on families whose infants experience sleep disturbance.

As expected, sleep patterns of 1-year-olds improved rapidly and maintained when intervened with, while still showing a gradual improvement when not intervened with, but with the expense of the risk of persistence and deterioration. Although both sleep disturbance and attachment security may be merely products of common contributing factors, infant attachment security also seems to play an important role in the improvement of sleep disturbances when not treated.

It must be noted that families who are willing to implement a behavioural sleep intervention, and those who are not, may indeed be characterised by different tolerance rates for crying and separation. Therefore, alternative approaches to behavioural sleep interventions with sufficient empirical support could meet the need of those families who seek help but have those less tolerant characteristics. Future studies using rigorous measures with larger sample size, allowing more representation of insecure attachment categories, are needed to be able to generalise the findings of this study. A further investigation of the trajectory of sleep problems for toddlers with secure and insecure attachment patterns and their possible relations to the development of emotion regulation skills is also essential to shed further light on some of the suggestions and implications of this study's findings.

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Appendices

Appendix A: Flyer

SCHOOL OF HEALTH SCIENCES

CANTERBURY SLEEP PROGRAMME

PUKEMANU/DOVEDALE CENTRE

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Calling for RESEARCH PARTICIPANTS

Do you have

a 11-15 MONTHS OLD INFANT

who

WAKES UP FREQUENTLY AT NIGHT?

and/or

TAKES MORE THAN 30 MINUTES TO SETTLE TO SLEEP?

Gökçe (*Gurkcha*) **Yılmaz Akdoğan** is recruiting participants for her PHD research project on ***Infant sleep and parent-infant relationships***

As a participant in this study, you may **choose** to:

A) Provide comparison data by sharing **your experiences with your infant, their sleep and your relationship with your infant** and in return, receive a **$50 petrol/food voucher** or,

B) Complete the procedures and receive **a free evidence-based assessment and intervention for your infant's sleep** from Child and Family Psychology staff at the University of Canterbury

To volunteer for this study, or to receive detailed information please contact

Gökçe *(Gurkcha)* at 021-155-4013 or at gokce.akdogan@pg.canterbury.ac.nz, and leave a message with your name and telephone number

We will call you back to confirm your eligibility for the research.

Appendix B: Human Ethics Approval

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN ETHICS COMMITTEE

Secretary, Lynda Griffioen
Email: human-ethics@canterbury.ac.nz

Ref: HEC 2015/97

12 October 2015

Gokce Akdogan
School of Health Sciences
UNIVERSITY OF CANTERBURY

Dear Gokce

The Human Ethics Committee advises that your research proposal "Sleep and attachment: effects of an intervention for infants with sleep disturbance on parent-infant relationships" has been considered and approved.

Please note that this approval is subject to the incorporation of the amendments you have provided in your email of 9 October 2015.

Best wishes for your project.

Yours sincerely

Lindsey MacDonald
Chair
University of Canterbury Human Ethics Committee

Appendix C: Parent Information Sheets (Comparison and Intervention)

Gökçe Yılmaz Akdoğan
Canterbury Sleep Programme
School of Health Sciences
University of Canterbury Private Bag 4800,
Christchurch 8140
Telephone: +64 211554013
Email: gokce.akdogan@pg.canterbury.ac.nz

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Infant sleep and parent-infant relationships

Information Sheet for Parent/Caregiver (comparison/no intervention group)

My name is Gökçe Yılmaz Akdoğan and I am currently a PhD student in the Child and Family Psychology programme at University of Canterbury. The aim of my research is to explore the association between infant sleep and the parent-infant relationship, in two groups of parents, those who opt to complete a sleep programme and parents who do not wish to complete a sleep programme. For this group we are interested in hearing from families who would like to help us explore the relationship between infant and the parent-child relationship without receiving an intervention with their 10-15 month-old infant who has difficulty settling to sleep or who wakes frequently at night.

For this purpose I am working with Associate Professor Karyn France (registered clinical psychologist) within the Canterbury Sleep Programme.

To track the development of your relationship with your child, the study will cover *up to a 6-month* period. We will explore your opinions on your child's characteristics and sleep, monitor any changes in your wellbeing and your child's daytime negative emotions (such as crying), nighttime sleep, and your interactions with your child during nighttime as well during a regular play-time. In order to acknowledge the time required to take part in the study you will receive a $50 petrol or food voucher.

Firstly, there will be a short interview on the telephone to hear a little about your child and their sleep and to answer your questions about the project. If you and we agree that your family is a good fit to participate in the study then this research will require two visits to the Pukemanu/Dovedale (Child and Family Psychology) Centre (PDC) at the Dovedale Ave part of the University of Canterbury, and up to eight home visits.

Summary of your participation:

- You will be invited to the PDC two times in *4 to 6-month* period to participate in an observational procedure with your infant. The first visit will also include an interview for us to learn about your infant's sleep and your experiences.
- Up to eight home-visits will be conducted to set up and then collect the video equipment for night time recording of your infant's sleep. Four of these home visits will be very short, aiming to collect the video equipment only.
- At four of the eight home visits, your regular play interaction with your infant will be video recorded for 15 minutes.
- You will be asked to fill out *three* questionnaires four times during the 6 month period, either during or after the home visit to be sent us in the provided envelope.
- You will also record your infant's daytime and nighttime sleep and what you do to soothe your infant to sleep onto a **sleep diary** that we will provide. This will be for 9 weeks in a row at the beginning of the 4-6-month period, and for two other periods of 1 week.

Further detail:

Clinic visits**:** During the first PDC visit there will be a longer interview to gather full information about your child and his/her sleep and your experiences with your infant’s sleep. You will have time to ask any questions about this study during the interview.

Also at this visit and at the second one, which will be at the end of *up-to-6-month* period, we will carry out the Strange Situation Procedure. For this 20 minute procedure we will observe, with you, your infant’s reactions when she/he is in an unfamiliar room and spends three minutes on two occasions with an unfamiliar woman from our programme. In case you and/or your infant feel stressed or uncomfortable during the procedure, you may choose to stop this procedure at any time you want.

Home visits**:** Four of the eight visits will allow me time set up the sleep recording video equipment (described below), and carry out the play observation and you will fill out 3 questionnaires. For the play observation you will be asked to play with your infant as you normally do for 15 minutes while it is recorded on a camera. The video recording will be used to observe the wide range of behaviours you and your infant display while you engage in play with your infant, such as the content and pace of your interaction; and your infant’s negative emotions. I will also answer any questions you have regarding the program. These visits will be approximately 30-40 minutes with the exception of the first which may take 1 hour. Other four home visits will only be done to collect the video equipment so they will be as short as 5 minutes.

Other measures: At the beginning and throughout the up-to-6 month period, we will ask you to complete sleep diaries and to complete *three* questionnaires at regular periods. The questionnaires will cover your views of your child's characteristics, sleep as well as an overview of your well-being.

Over the *up-to-6 month* period we will also set up a low-illumination camera which will record what happens during the night in your infant's cot. Only the child and his or her bed will be visible, but background noise will be able to be heard. This will happen on approximately 12 nights on four occasions (3 nights at a time) over the 4-6 months period. This is a well-established sleep-research procedure and all you will need to do is help us plan where to position the equipment. I will set up the equipment and programme it to start and finish at set times, then return to collect it. This will not require anyone entering your home at night. We will also ask you to let us know if there is any problem with the operation of the camera.

Our responsibilities:

Participation in the study is voluntary and you can withdraw at any stage without penalty. If this occurs, any information relating to your family will not be included in the study and will be destroyed, provided that this remains practically achievable.

All information you provide to the research programme will be confidential, unless Associate Professor France or I have concerns about anyone's safety. In this situation, we would discuss these concerns with you, if possible, before deciding what action to take.

I will take care to ensure the confidentiality of all data gathered for this study. I will also take care to ensure anonymity in publications of the findings. Prior to submission of my thesis, all coded data will be accessible only by me and my supervisors with two exceptions: i) some of the data regarding the intervention phase may be accessed by the PDC staff member who runs your sleep intervention, when applicable; ii) a research assistant may be required to code some of the interaction videos for statistical purposes, in which case all identifying information will be kept from this research assistant who must also sign a confidentiality agreement.

All data will be stored securely in password protected files and locked storage at the University, and will be destroyed ten years following the study.

Data from this study will be published in a thesis and possibly in academic journals, and may be presented at national or international forums or conferences for education purposes. You will have the opportunity to view a summary of the study findings on completion of the research project. If you would like to receive this information, please provide your email address on the consent form. If you have any questions at any stage, or would like more information about the study, you can contact me (details above), or Associate Professor Karyn France (details below).

This project has received ethical approval from the University of Canterbury Educational Research Human Ethics Committee (HEC 2015/97). Should you have any complaints, please address them to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

Thank you for taking time to consider this information sheet. If you understand all of the above information and agree to take part in this study, please sign the parent/caregiver consent form and return it with the envelope provided.

Kind Regards,

Gökçe Yılmaz Akdoğan

Dr Karyn G France,

Registered Clinical Psychologist,

Coordinator Child and Family Psychology Programme

University of Canterbury

Private Bag 4800, Christchurch, New Zealand. Ph (03) 364 2610 Fax (03) 364241.

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UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Infant sleep and parent-infant relationships

Information Sheet for Parent/Caregiver (Intervention group)

My name is Gökçe Yılmaz Akdoğan and I am currently a PhD student in the Child and Family Psychology programme at University of Canterbury. The aim of my research is to explore whether implementing a sleep intervention programme for infants with sleep problems will change the nature of the parent-infant relationship.

For this purpose I am working with Associate Professor Karyn France (registered clinical psychologist) within the Canterbury Sleep Programme. The Canterbury Sleep Programme has worked over many years to establish which sleep programmes are the most gentle, while also being effective.

For this research we will recruit families who would like to carry out a free sleep programme with their 10-15 month-old infant who has difficulty settling to sleep or who wakes frequently at night. If this describes your child you are invited to make contact with me.

To track the development of your relationship with your child, the study will cover a 4 to *6-month* period. We will explore your opinions on your child's characteristics and sleep problems, monitor any changes in your wellbeing and your child's daytime negative emotions (such as crying), nighttime sleep, and your interactions with your child during nighttime as well during a regular play-time.

Before the intervention, there will be a short interview on the telephone to hear a little about your child and his/her sleep and to answer your questions about the project. If you and we agree that the project is a good fit with your and your child's needs then this research will require two visits to the Pukemanu/Dovedale (Child and Family Psychology) Centre (PDC) at the Dovedale Ave part of the University of Canterbury, and approximately eight home visits.

Summary of your participation:

- You will be invited to the PDC two times in *up to a 6-month* period; before the intervention and *4 to 6 months* after your first visit and participate in an observational procedure with your infant. The first visit will also include an interview to receive detailed information about your infant's sleep and introduce the intervention.
- Home-visits will be conducted twice in each phase i.e. before, during and after intervention and at follow up, to set up and then collect the video equipment for night time recording of your infant's sleep.
- At four of the eight home visits, i.e. once in each phase, your regular play interaction with your infant will be video recorded for 15 minutes.
- You will be asked to fill out four questionnaires at four phases either during or after the home visit to be sent us in the provided envelope.
- You will record your infant's daytime and nighttime sleep, what you do to soothe your infant to sleep onto a sleep diary that we will provide. This will be for 7 to 21 days before intervention, 4-6 weeks during intervention, 1 week after the intervention, and 1 week at the follow up.

Further detail:

Clinic visits**:** During the first PDC visit there will be a longer interview to gather full information about your child and his/her sleep and to explain possible interventions. The sleep programme will be negotiated with you so you are comfortable with it and clear about how to carry it out. You will be contacted regularly as you carry out the sleep programme, so we can answer any questions and help you to solve any problems which may occur.

Also at this visit and at the second one, which will be at the end of the 4-6-month period, we will carry out the Strange Situation Procedure. For this 20 minute procedure we will observe, with you, your infant's reactions when she/he is in an unfamiliar room and spends three minutes on two occasions with an unfamiliar woman from our programme. In case you and/or your infant feel stressed or uncomfortable during the procedure, you may choose to stop this procedure at any time you want.

Home visits**:** These visits will be approximately 30 minutes with the exception of the first which may take between 45-50 minutes. These visits will allow me time to set up the intervention, set up or collect the sleep recording video equipment (described below), touch base and discuss progress and carry out the play observation. For this observation, on four occasions, at home, you will be asked to play with your infant as you normally do for 15 minutes while it is recorded on a camera. The video recording will be used to observe the wide range of behaviours you and your infant display while you engage in play with your infant, such as the content and pace of your interaction; and your infant's negative emotions such as crying or fussiness.

Other measures: At the beginning and throughout the intervention and follow-up period, we will ask you to complete sleep diaries and to complete *three* questionnaires at regular periods.

The questionnaires will cover your views of your child's characteristics, sleep as well as an overview of your well-being.

Over the 4-6-month period we will also set up a low-illumination camera which will record what happens during the night in your infant's cot. Only the child and his or her bed will be visible, but background noise will be able to be heard. This will happen on approximately 12 nights on four occasions (3 nights at a time) over the 4-6 months period. This is a well-established sleep-research procedure and all you will need to do is help us plan where to position the equipment. I will set up the equipment and programme it to start and finish at set times, then return to collect it. This will not require anyone entering your home at night. We will also ask you to let us know if there is any problem with the operation of the camera.

Our responsibilities:

Participation in the study is voluntary and you can withdraw at any stage without penalty. If this occurs, any information relating to your family will not be included in the study and will be destroyed, provided that this remains practically achievable.

All information you provide to the research programme will be confidential, unless Associate Professor France or I have concerns about anyone's safety. In this situation, we would discuss these concerns with you, if possible, before deciding what action to take.

I will take care to ensure the confidentiality of all data gathered for this study. I will also take care to ensure anonymity in publications of the findings. Prior to submission of my thesis, all coded data will be accessible only by me and my supervisors with two exceptions: i) some of the data regarding the intervention phase may be accessed by the PDC staff member who runs your sleep intervention, when applicable; ii) a research assistant may be required to code some of the interaction videos for statistical purposes, in which case all identifying information will be kept from this research assistant who must also sign a confidentiality agreement.

All data will be stored securely in password protected files and locked storage at the University, and will be destroyed ten years following the study.

Data from this study will be published in a thesis and possibly in academic journals, and may be presented at national or international forums or conferences for education purposes. You will have the opportunity to view a summary of the study findings on completion of the research project. If you would like to receive this information, please provide your email address on the consent form. If you have any questions at any stage, or would like more information about the study, you can contact me (details above), or Associate Professor Karyn France (details below).

This project has received ethical approval from the University of Canterbury Educational Research Human Ethics Committee (HEC 2015/97). Should you have any complaints, please address them to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

Thank you for taking time to consider this information sheet. If you understand all of the above information and agree to take part in this study, please sign the parent/caregiver consent form and return it with the envelope provided.

Kind Regards,

Gökçe Yılmaz Akdoğan

Dr Karyn G France,

Registered Clinical Psychologist,

Coordinator Child and Family Psychology Programme

University of Canterbury

Private Bag 4800, Christchurch, New Zealand. Ph (03) 364 2610 Fax (03) 364241.

Appendix D: Parent Consent Form (Intervention and Comparison)

Gökçe Yılmaz Akdoğan

Canterbury Sleep Programme

School of Health Sciences

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UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Infant sleep and parent-infant relationships

Consent Form for Parent/Caregiver

I/We have been given a full explanation of this project and have had the opportunity to ask questions.

I/We understand what is required if I/we agree to take part in the research.

I/We understand that participation is voluntary and I/we may withdraw at any time without penalty. Withdrawal of participation will also include the withdrawal of any information I/we have provided should this remain practically achievable.

I/We understand that all information provided to the research programme will be confidential, unless Associate Professor France or the researcher have concerns about anyone's safety. In this situation, these concerns would be discussed with us, if possible, before a decision about what action to take, is made.

I/we understand that all data collected for this study will be kept in locked and secure storage facilities at the University of Canterbury and will be destroyed after ten years. I/we understand that any information or opinions I/we provide will be kept confidential to the researchers and that any published or reported results will not identify the participants.

I/We understand that a thesis is a public document and will be available through the UC Library and I am/we will be able to receive a report on the findings of the study. If I am/we are interested in receiving this, I/we will provide my/our email address details below.

I/We understand that if I/we require further information, I/we can contact the researcher, Gökçe Yılmaz Akdoğan, or her supervisor Associate Professor Karyn France. If I/we have any complaints, I/we can contact the Chair of the University of Canterbury Human Ethics Committee, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz)

By signing below, I am/we are declaring that I/we have read and understood the statements above and agree to participate in this study.

Name (please print)

____

Your signature ______________________________________

Date__________________________ Email address for report

____ Please return this consent form in the envelope provided. Thank you for your time. Gökçe Yılmaz Akdoğan.

Appendix E: Sleep Diary Booklet (Cover and Example Diary)

CANTERBURY SLEEP PROGRAMME

SLEEP DIARY

2016

*A brief explanation on **how to:***

1. *Record 1 day of the week down each column*

2. ***Day sleep:** Record the time your child is placed down, and the time they wake up for either 1 or 2 sleeps, if applicable. Record if the sleep is away from home, for example in the car. Indicate any code words under KEY at the **bottom** of the **day sleep section**. (See examples on the next page)*

3. ***Night sleep:***

    a. *Record if at home or out. State the actual bedtime and ideal bedtime for that night.*

    b. *Record the time your child goes to bed, and the time they become silent.*

    c. *Record number of times awake, the duration, what your child did and what you did by using the code words if necessary.*

4. *Indicate any code words under KEY at the **bottom** of the **night sleep section**. (See examples on the next page)*

If you have any questions, please do not hesitate to ask us.

Thank you for filling in the sleep diaries!

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Example Sleep Diary

NAME:

Date	19.01.2016	20.01.2016	21.01.2016	22.01.2016	23.01.2016	24.01.2016	25.01.2016
Day Sleep							
Time down	10.00am	10.30am	-				
Time awake	11.30am	11.00am	-				
Where	Cot	D	-				
Time down	14.00	-	12.00				
Time awake	14.30	-	13.00				
Where	Car	-	couch				
Key:	e.g. D=dad's arms						
Night Sleep							
Where	Cot (or o/b)	o/b (or cot)	p/b				
Bedtime/ comment	7pm Cr at b/t						
Time from in bed to silence + Nature of sounds& mins	30min Cr=10 min Ch=10 min						
What did you do	N, R, Cu, B/f						
Night Wakings: Please note down:- time awake - approx duration -what did child do? -what did you do? #1	10.30pm-10min Cr=2min B/f, R						
#2	12.30am-20min N, R, bo/f						
#3	2am-10min Scr Moved to p/b						
#4	4.15am-12min Cr Cu, B/f						
#5	5am-15min Cr R, Cu, N						
#6							
#7							
Time up for the day	6.00 am						

Child Response Key:
e.g. o/b=own bed p/b= parents' bed b/t= bedtime
Cr=cry Ch=chat Scr= Scream

Comments:

Parent Response Key: e.g. N=nappy change Cu= Cuddle
B/f= breastfeed bo/f=bottle feed R= Rock

Appendix F: Coding Sheet for Frequency of Observed NE

ID and name of the Video	**Time and incident of cry** *(In 15 seconds intervals)*	**Time and incident of fuss** *(In 15 seconds intervals)*	**Time and incident of rejecting mother's bids** *(In 15 seconds intervals)*	**Time and incident of throwing/hitting toys** *(In 15 seconds intervals)*	**Total Number of discrete events**	**NE in 1-4 Scale**

Appendix G: Parent Guide to SSP

Dear Parent,

Welcome to the Pukemanu/Dovedale Centre and thank you for participating in our study.

Here is some information for you before we start our interviews today.

<u>Some Basic Information</u>:

We would like you and your child to be as fresh and comfortable as possible. Therefore, if you need to feed your child or change your child's nappy please do this before we start.

- **Food and Beverages**: We will get you a cup of tea or coffee before the clinical interview. If you need anything at other times there is a café right next to the Waimairi building (where we are now) where you can buy some snacks and coffee, tea or juice. When you go out of the main door and walk a few meters to the left, you will see the café on the left hand side.
- **Toilet and nappy change**: The toilets are located on the 2nd floor of this building. Take the elevator from the waiting lounge and press 2. You will see the toilets located right across from the elevator. There is also a nappy change table available right at the entrance of the women's toilets.

<u>Timeline for the day's activities</u>:

Today, first we will start with the *Strange Situation Procedure* for which you will see the details below. **This will take approximately 20 minutes in total**.

When you and your child feel ready to continue, we will move on to *the clinical interview* in which we will ask you some questions about your child's sleep and how you have been managing this. **This will take approximately 60 minutes**.

If you have any other questions about today, please do not hesitate to ask.

☺Thank you for your time and cooperation!

We hope to see you again later. ☺

<u>Information on the Strange Situation Procedure</u>:

- We are going to start with an activity where we want to see how your baby responds to a new place and a stranger both when you are with him/her and when he/she is alone. This procedure lets us see the strategies your child uses to manage a brief, mildly stressful situation
- If you've brought **toys from home**, **please do not use them during the procedure** because we want all children to use the same toys.
- If you have a **pacifier** we'll ask you **not to use it** and/or if you're breastfeeding/bottle feeding we'll ask you **not to breastfeed/bottle feed during the procedure** because we want a clear camera shot of your baby's face.
- Try to think about this situation as ***a waiting room*** where you are waiting for a dentist or your doctor while your baby is keeping busy with the toys in the room.
- Throughout this procedure, there will be an assistant to guide you through each phase. In addition, we will provide you with a cue sheet telling you what to do while you are in the room.
- When you walk into the room, **introduce your child to the toys** then **sit down to the <u>chair further away from the door</u>**, look at the magazine or your phone**-look busy-**. If your child **interacts with you act as you would normally** do ***without leaving your chair***.
- After 3 minutes, the stranger (a female student) will come in and sit quietly for a while then she will talk to you and then she will play with your child. When you hear **2 knocks** on the glass you need to *leave the room*. **Leave the room as you would normally leave a room.** The assistant will meet you outside the room.
- Children all have different reactions to this procedure. Some get upset and cry, some think it is fun and play the whole time, and others don't seem to care either way. After you leave the

room, you can wait and watch your child's behaviours from the observation room. **<u>If your baby is very upset for 30 seconds, we'll speed up and get you back in the room.</u>** If your child is not very upset the episode will **normally take 3 minutes**. We'd really like to get through the whole task, but of course, you can ask us to end a part early or to end the whole procedure if you want.

- When you go back to the room: ***first <u>call your child's name</u>, then <u>open the door</u> and wait for your child's response for a second***, if **your child initiates** an interaction with you, **respond to that** and **then sit back to the same chair** you were sitting at the beginning. If your child **does not initiate** an interaction, ***go back to your chair without initiating an interaction with your child***. We will give you a cue sheet to help you follow these instructions.
- When you **hear 2 knocks** again, **leave** your child in the room and **go out quickly as you would normally walk out of a room when you are in a hurry**. When you're out, you will be invited to the observation room where **you can watch your child from the camera**. After **30 seconds to 3 minutes**, **the stranger will come in and try to calm your child down and 3 minutes after that you will go in**. However, if your child cries the whole time and is not calming down in the presence of stranger for 30 seconds, we will finish this episode whenever you decide.
- At the last episode, you will again **call your child's name first**, then **open the door**, **wait for a second to see your child's response**, and then **respond as you would normally do in a similar situation**. This time, you don't have to go back to your chair.
- When the procedure is over, the assistant will come in and congratulate you both and give your child a balloon. Then you can have some time to relax before we move on to the next phase of our meeting today.

☺ Thank you! ☺

Appendix H: Initial Interview Agenda

Intro

- Intro me, my role, the team, clinic director
- Confidentiality, a/v consent
- What we'll do today

Presenting Problems

- Sleep and any other?
- Functional assessment of each one
- What does a typical nighttime look like?
- Goal: what would it look like if we successfully helped you?

History of Presenting Problems

- What was the first thing that happened that made you realise there was a problem?
- Has the problem been continuously there, or come and gone?
- What changes have you noticed over time?
- How often does it occur? Every night?
- How long does it last?
- What is the impact of it on child? Family? Others?
- What attempts have been made to change it? What strategies do you use?
- What works, what doesn't?
- Have you received help for this before? Who, what, outcomes?

Developmental History

- What was life like before she/he came?
- How was the pregnancy? And the birth?
- How did you both feel when she/he was born?
- What was she/he like as a baby? Social, seek comfort, cry a lot, easy to soothe?

- How did parents adjust to type of baby she/he was? Siblings?
- How was her/his sleep then? Breastfed? Until when?
- Were milestones achieved on time? Sitting, crawling, standing, walking, talking… Temperament: active or placid child?
- Health & medical: any other health problems?
- Who are other significant people in his life?

Assessment of the Family

- How does each parent feel about life in general? (anxiety, depression, sleep disturbance, anger management, setting limits, looking after themselves)
- Is there any stress in your life apart from the presenting problem?
- Describe your family of origin, and partners?
- What effects does this have on you? Your parenting?
- Any family history of sleep issues?

Appendix I: Supplementary Results. (Level 1b).

Preliminary analysis of Phase 1 data with 18 participants. By the Phase-2 assessments, six participants dropped out of the study (as outlined in the Method chapter) and 18 participants continued and completed all phases of the study. In Level 1b, Phase-1 data of these participants were analysed in order to present the pre-test information which informed the second and third level of analysis in the Results section.

Similar to the Level 1a presented in the Results chapter, descriptive and exploratory analyses were presented separately. Descriptive analysis covered all categorical data as frequencies and between-group comparisons were conducted using standard Chi-Square (χ^2) test. All continuous data were compared for groups based on the categorical attachment and sleep variables (for example, secure vs insecure attachment, or, having ISD since birth or not), and parents' help-seeking preferences, i.e., help-seeking (referred to below as 'intervention') vs non-help-seeking (referred to as 'comparison') groups." Group medians were compared using the non-parametric statistics, namely, the Kruskal-Wallis and Mann-Whitney *U*-Test. Discriminant Function Analysis (DFA) was used to predict group membership for help-seeking preferences using continuous independent variables.

Exploratory analysis examined pairwise bivariate correlations of within-sleep variables, within-attachment variables, and between attachment, sleep, and parent-infant secondary variables. Standard multiple regression analysis then followed to identify variables predicting selected sleep and attachment variables. The minimum alpha level was $p < .05$, two tailed, for statistical significance.

Descriptive analysis (*n* = 18).

Categorical attachment variables. The categorical attachment variables were the normative attachment patterns (ABC) and the binary categorisations of infants with secure/insecure and B4/non-B4 attachments. The distributions were reported as follows.

The distribution of normative attachment patterns. After six participants left the study, 15 infants (83%) remained in the B classification, one infant remained in A (6%), and two infants (11%) remained in the C pattern attachment (Table 20). Seven (39% of total) infants with B4 attachment pattern continued the study and they comprised 47% of the total B classification group.

The binary attachment variables. The sample was further divided into secure (*n* = 15, 83%) and insecure (*n* = 3, 17%) attachment groups. The sample characteristics were also compared for infants with the B4 (*n* = 7, 39%) and non-B4 (*n* = 11, 61%) attachment groups.

Categorical sleep characteristics.

Current sleep, history, and location of sleep. Frequencies and percentages are provided in Table 20. Among 18 families, 12 infants (67%) were reported to have sleep disturbance since birth, all mothers breastfed their infants at nighttime. Three infants were sleeping in their own cot for the whole night. Four (22%) parents practiced intentional cosleeping and 61% of parents (*n* = 11) practiced reactive cosleeping. Ten families (56%) reported unsuccessfully trying some sort of behavioural sleep intervention in the past either self-initiated or with the help of a professional.

Table 20. *Attachment patterns and sleep characteristics of participants in intervention and comparison groups at Phase-1 (n=18)*

Variables	Phase-1 (*n* = 18) Intervention *n*= 10		Comparison *n* = 8		Total *n* = 18		
Attachment[1]	*n*	%	*n*	%	*n*	%	X^2
A	1	10	0	0	1	6	
B	8	80	7	87	15	83	
C	1	10	1	13	2	11	
							.855
Sleep characteristics							
ISD since birth	4	40	8	100	12	67	**7.20***
Breastfeed at night	10	100	8	100	18	100	-
Intentional cosleeping	0	0	4	50	4	22	**6.42***
Reactive Cosleeping	8	80	3	37	11	61	**6.46***
Tried BSIs before	7	70	3	37	10	56	1.90

Note. [1] The distribution of normative attachment patterns. A = Avoidant attachment pattern, B =Secure attachment pattern, BSI = Behavioural Sleep intervention, C = Ambivalent/Resistant attachment pattern, ISD = Infant Sleep Disturbance, *p < .05.

Continuous attachment variables. A summary of means, standard deviations, medians, *p* values of all continuous variables from intervention and comparison groups (*n* = 18) were provided in Table 21.

Attachment resistance. The range of the total resistance scores from SSP episodes 5 and 8 was 2 to 10 (possible range 2 – 14). The mean = 4.39, *SD* = 2.25 and the median = 4.0. The distribution was negatively skewed.

Attachment Security. The scores ranged from -6.19 to 4.78. The mean = 1.79, *SD* = 2.65 and the median = 2.69. The distribution was strongly positively skewed.

Continuous sleep variables.

The Severity of sleep problems. The Richman Composite Sleep Scores (CSS) for 18 participants ranged from 9 to 20 with the mean = 13.89, *SD* = 3.06, and the median = 14. According to the cut-off points, all infants had PSD and 72% (*n* = 13) had severe PSD.

Parental nighttime involvement. The average intensity of parent involvement at nighttime, as measured with the BSS ranged from 3 to 5 (possible range 1 5) with the mean = 4.49, *SD* = .77, and the median = 5. Thus, all parents were highly involved with the infant while the infant was falling asleep.

Table 21. *Means, standard deviations, medians, and p values of attachment, sleep, infant and parent secondary variables of total sample (n = 18), intervention (n = 10), and comparison (n = 8) groups*

	Total (*n* = 18)		Intervention (*n* = 10)		Comparison (*n* = 8)		
Variables	*M (SD)*	*Mdn*	*M (SD)*	*Mdn*	*M (SD)*	*Mdn*	*U*[1]
Attachment							
Resistance	4.3 (2.2)	4	4.2 (1.8)	4	4.6 (2.7)	4	39.0
Security	1.7 (2.6)	2.6	1.8 (1.9)	2.17	1.7 (3.5)	2.8	32.0
Sleep							
The severity of sleep problems	13.8 (3.0)	14	12.9 (2.7)	13.5	15.1 (3.1)	15	24.0
Parental night time involvement	4.4 (.77)	5	4.1 (.89)	4.33	4.8 (.30)	5	22.5
Infant negative emotionality							
Perceived NE (ICQ)	15.5 (4.6)	14.5	14.1 (4.4)	12.5	17.2 (4.6)	18.5	24.0
Frequency of observed NE	4.3 (3.8)	3	4.7 (4.1)	3	4.0 (3.5)	3.5	40.0
NE Scale	1.7 (1.1)	1	2.0 (1.1)	1.5	1.5 (1.0)	1	50.0
Cry duration at SSP separation episodes	21.8 (12.4)	24	18.7 (11.4)	21.5	25.7 (13.3)	32.5	23.0
Parental daytime sensitivity	.56 (.29)	.65	.65 (.19)	.68	.45 (.37)	.59	53.0
Parental cognitions about infant sleep (MCISQ)							
Limit Setting	17.2 (4.5)	18	15.7 (5.0)	17	19.2 (3.1)	19.5	22.5
Doubt	8.5 (4.5)	7.5	8.6 (4.4)	8	8.5 (5.0)	7.5	40.5
Anger	7.1 (3.4)	7.5	7.3 (3.5)	7	6.8 (3.4)	8	41.0
Feeding	7.7 (3.1)	9	7.8 (2.9)	9	7.7 (3.4)	8.5	40.5
Safety	3.4 (2.7)	3	3.8 (3.2)	3	3.0 (1.9)	3	44.0
Total	44.1 (11.2)	41	43.2 (12.8)	39.5	45.3 (9.6)	44.5	35.5
Parental wellbeing (DASS-21)							
Depression	4.78 (6.21)	2	5.2 (7.3)	2	4.2 (4.8)	4	41.0
Anxiety	4.11 (5.29)	2	4.0 (6.3)	1	4.2 (4.0)	4	32.5
Stress	11.78 (7.75)	9	11.2 (8.8)	9	12.5 (6.7)	12	35.0
Total	20.6 (17.4)	14	20.4 (20.4)	12	21 (14.2)	20	35.0

Note. [1] Mann-Whitney U-Test. DASS-21= 21-item Depression, Anxiety, Stress Scale, ICQ= Infant Characteristics Questionnaire, MCISQ= Maternal Cognitions about Infant Sleep Questionnaires.

Group comparisons for attachment categorical variables. Secure/insecure and B4/Non-B4 attachment groups were compared for the median severity of sleep problems, infant negative emotionality, parental nighttime involvement, parental daytime sensitivity, cognitions about infant sleep, and wellbeing using the independent samples Mann-Whitney *U*-Test.

There were no statistical differences between groups for secure-insecure comparison. Infants with B4 attachment pattern cried longer (n = 7, *Mdn* = 34) than non-B4 infants (n = 11, *Mdn* = 16) during the separation episodes of SSP (U = 75, p = .000).

Infants with A, B, and C attachment patterns were compared using the independent samples Kruskal-Wallis test for the median severity of sleep problems, infant negative emotionality, parental nighttime involvement, parental daytime sensitivity, cognitions about infant sleep, and wellbeing. Results indicated no statistically significant median differences between groups.

Group comparisons for sleep categorical variables. The sample was divided into two groups based on the time of onset of PSD (Birth, n = 12 vs primary or secondary PSD, n = 6), cosleeping (intentional, n = 4 vs reactive, n = 11), and previous BSI attempts (no attempts n = 8 vs at least one attempt, n = 10).

These groups were compared for the median severity of sleep problems, attachment security and resistance, infant negative emotionality, parental nighttime involvement, parental daytime sensitivity, cognitions about infant sleep, and wellbeing using the independent samples Mann-Whitney *U*-Test.

Results indicated that the severity of sleep problems (U = 7, p = .005) and parental nighttime involvement (U = 14, p = .041) was greater for infants with PSD since birth (n = 12, *Mdn* = 15.5) than infants who developed PSD later (n = 6, *Mdn* = 11.5) whereas infants who developed PSD later (*Mdn* = 3) received higher scores on negative emotionality scale than infants with PSD since birth (*Mdn*=1), *U* = 60, *p* = .024.

In order to compare families in intentional (*n* = 4) and reactive cosleeping (*n* = 11) groups, infants who only slept in their cot (*n* =2) were omitted from the analysis. Results indicated no statistically significant differences between groups.

Families were also compared for their previous BSI attempts by separating the sample into those who had tried interventions at least once (*n* = 10) and those who had not (*n* = 8). Results indicated that parents who had tried an intervention at least once scored higher on (concerns about) Feeding subscale of MCISQ (*Mdn* = 9.5) than parents who had not used an intervention (*Mdn* = 6), *U* = 65.5, *p* = .021.

Comparison of intervention and comparison groups (n = 18). Cross tabs were computed to compare demographics, categorical attachment variables, current sleep, history, and location of sleep data of families who wanted to receive a BSI (intervention, *n* = 10, infants' mean age in months = 13.28, *SD* = 1.64) and those who did not (comparison, *n* = 8, infants' mean age in months = 13.20, *SD* = 1.27) using the χ^2 test (see Table 20).

The median severity of sleep problems, attachment security, disorganisation, and resistance, infant negative emotionality, parental nighttime involvement, parental daytime sensitivity, cognitions about infant sleep, and wellbeing of the intervention and comparison groups were compared using the independent samples Mann-Whitney *U*-Test (Table 21). Results were as follows.

Demographics. There were no differences in the distribution of child gender, parity, and day-care attendance, mothers' working status, primary caregiver's ethnicity, SES level, and parents' relationship status between groups.

Attachment variables. There were no differences between intervention and comparison groups in the distribution of attachment secure/insecure, B4/nonB4, and ABC categories.

Current sleep, history, and location of sleep. Intervention and comparison groups did not differ in the frequency of breastfeeding at nighttime and previous BSI attempts. All children in the comparison group were reported to experience sleep disturbance since birth however, only four infants in the intervention group had sleep disturbance since birth (χ^2= 7.200, *Fisher's exact test* =.013). The difference in cosleeping practice was also evident. While parents in the non-help seeking group tended to prefer intentional cosleeping, parents in the intervention group tended to practice reactive cosleeping (χ^2= 6.464, p=.039).

Continuous variables. Two groups' medians were not significantly different for any of the continuous variables when compared with the Mann-Whitney *U*-Test.

Exploratory analysis (n = 18).

Correlations of within-attachment variables at Phase-1. As Figure 28 shows, attachment security scores significantly correlate with attachment resistance (r = -.660, p<.01) in a negative direction and the R^2 was .436.

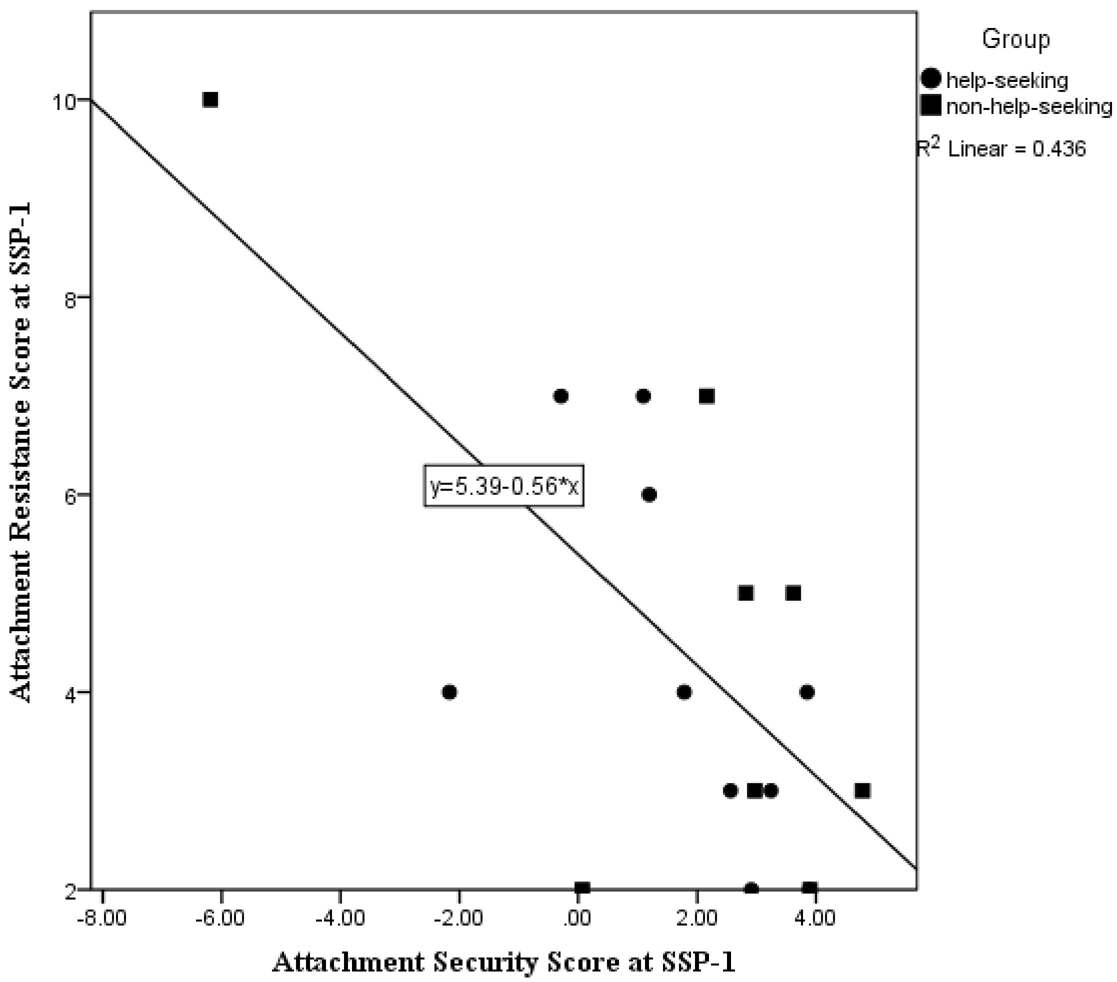

Figure 28. Scatterplot and linear regression line of the relationship between the attachment security score as measured by the modified Richters' Formula and attachment resistance score from the interactive attachment behaviour scale at Phase 1 (n = 18).

Note. Participants in intervention (n =10) group was indicated with circle and participants in comparison (n = 8) group was indicated with rectangle.

Correlations of within-sleep variables at Phase-1. There was a positive linear relationship between the severity of sleep problems and the parental nighttime involvement (r = .545, p = .019) and the R^2 was .297 (Figure 29).

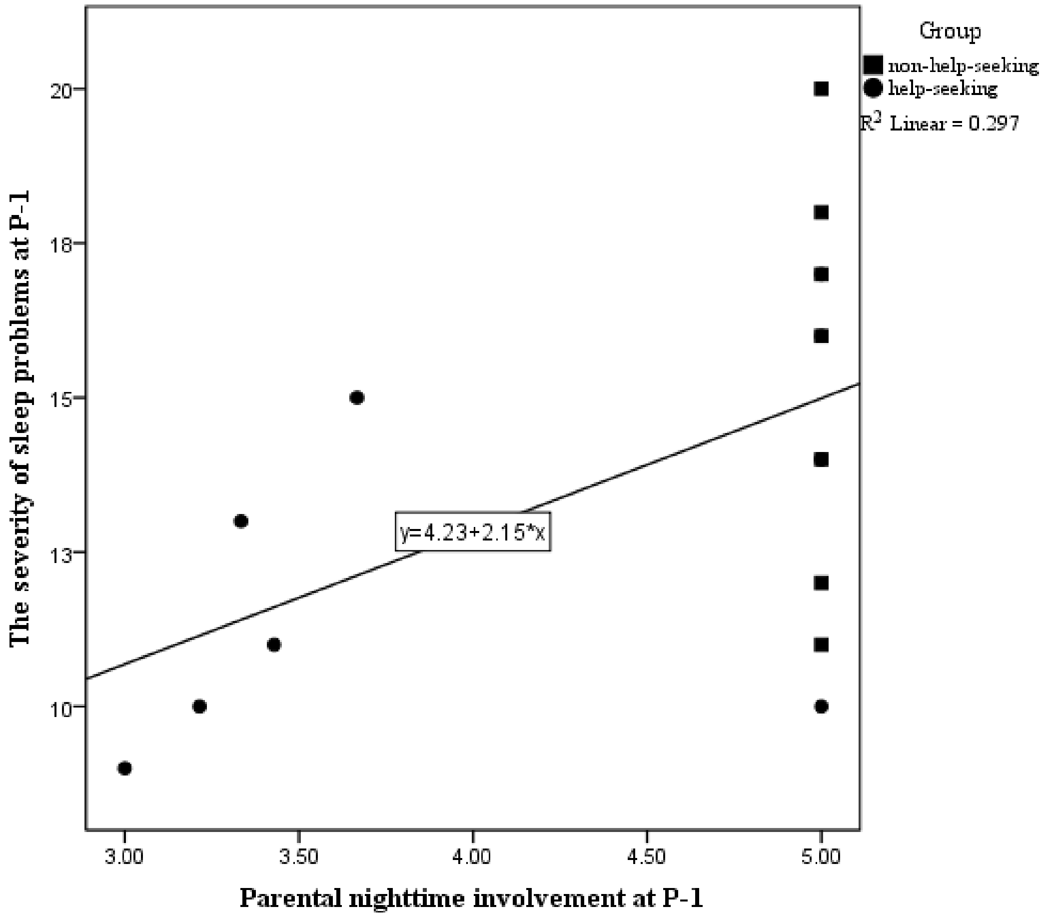

Figure 29. Scatterplot and linear regression line of the relationship between the severity of sleep problem and parental nighttime involvement at Phase-1 (n = 18).

Note. Participants in the ‘intervention (n = 10) group were indicated by circles and participants in the comparison (n = 8) group were indicated with rectangles.

Associations between attachment and sleep variables at Phase-1. Pairwise bivariate correlations were also computed for the severity of sleep problems, parental nighttime involvement and attachment security and resistance scores (Table 22). There was a significant correlation between attachment resistance score and the severity of sleep problems (r = -.496, p = .036) in the negative direction. Correlations between the severity of sleep problems and attachment security (r = .321) were moderate but not statistically significant.

Table 22. *Pearson correlation coefficients for sleep and attachment variables at Phase-1 (n=18)*

Variables	Attachment security	Attachment Resistance
The severity of sleep problems	.321	**-.496***
The average intensity of parent involvement at nighttime	.022	-.070

Note: * Correlation is significant at the 0.05 level.

Secondary variable associations.

Infant negative emotionality, attachment and sleep variables. There were no significant relationships between infant negative emotionality measures and any attachment variables (see Table 23). There was a significant negative correlation between negative emotionality scale (NE Scale) and the severity of sleep problems (r = -.490, p<.05). There was a moderate but not significant correlation between the severity of sleep problems and frequency of observed NE (r = -.453) in the negative direction. Parental involvement at nighttime was also moderately but not significantly correlated with NE Scale (r = -.421) and cry duration at SSP separation episodes (r = .314).

Table 23. *Pearson correlation coefficients matrix for infant negative emotionality, attachment and variables at Phase-1 (n = 18)*

Variables	1	2	3	4	5	6	7	8
8. Cry Duration at SSP Separation Episodes	.308	.325	.087	.314	.051	.073	-.020	—
7. NE Scale	.246	-.010	**-.490***	-.421	-.125	**.905****	—	
6. Frequency of Observed NE	.092	.132	-.453	-.242	-.002	—		
5. Perceived NE	-.122	.165	-.107	-.161	—			
4. Parental nighttime involvement				—				
3. The severity of sleep problems			—					
2. Attachment resistance		—						
1. Attachment security	—							

Note. *. Correlation is significant at the 0.05 level. **. Correlation is significant at the 0.01 level.

Parental daytime sensitivity, cognitions about infant sleep, attachment and sleep variables. As Table 24 shows attachment resistance was moderately but not significantly correlated with anger sub-scale of MCISQ (r = -.377). Among parental cognitions about infant sleep, there was a moderate but not significant positive association between the severity of sleep problems and MCISQ Limit setting subscale (r = .365). There was also a moderate but not significant negative correlation between parental nighttime involvement and MCISQ Doubt subscale (r = -.370). There were no statistically significant correlations between parental daytime sensitivity and sleep variables.

Table 24. *Pearson correlation coefficients matrix for parental daytime sensitivity, cognitions about infant sleep, sleep and attachment variables at Phase-1 (n = 18)*

Variables	1	2	3	4	5	6	7	8	9	10	11
11. MCISQ Total	.143	-.253	.223	-.146	-.242	**.572***	**.757****	**.569***	**.626****	**.481***	—
10. MCISQ Safety	.174	.115	-.299	-.108	-.347	.023	**.530***	-.094	.167	—	
9. MCISQ Feeding	.150	-.004	.251	-.051	-.018	.312	.349	.140	—		
8. MCISQ Anger	-.185	-.377	.213	-.049	-.073	.218	.391	—			
7. MCISQ Doubt	.264	-.222	.084	-.353	-.370	.020	—				
6. MCISQ Limit Setting	.024	-.182	.313	.129	.045	—					
5. Parental Daytime Sensitivity	.052	-.054	.124	-.143	—						
4. Parental nighttime involvement				—							
3. The severity of sleep problems			—								
2. Attachment Resistance		—									
1. Attachment Security	—										

Note: *. Correlation is significant at the 0.05 level. **. Correlation is significant at the 0.01 level. MCISQ=Maternal Cognitions about Infant Sleep Questionnaire.

Parental wellbeing, attachment, and sleep variables. There were moderate but not significant correlations between attachment security and DASS-21 total score (r = -.368) and depression (r = -.366), anxiety (r = -.314), and stress (r = -.321) subscales in the negative direction (see Table 25). Parental daytime sensitivity was also included in the matrix to demonstrate correlations with the DASS-21 scores which were not significant.

Correlations between the severity of sleep problems and DASS-21 scores of parents were very weak. However, the parental nighttime involvement was moderately, but not significantly, correlated with overall wellbeing (r = -.359), anxiety (r = -.351), and stress (r = -.332) scores of parents. Parental daytime sensitivity was not significantly correlated with sleep variables and DASS-21 scores.

Table 25. *Pearson correlation coefficients matrix for parental wellbeing, parental daytime sensitivity, sleep and attachment variables at Phase-1 (n=18)*

Variables	1	2	3	4	5	6	7	8	9
9. DASS21 Total	-.368	.068	-.073	-.359	-.249	**.891****	**.905****	**.921****	—
8. DASS21 Stress	-.321	.073	.029	-.332	-.206	**.697****	**.757****	—	
7. DASS21 Anxiety	-.314	.055	-.144	-.351	-.168	**.748****	—		
6. DASS21 Depression	-.366	.053	-.119	-.296	-.301	—			
5. Parental Daytime Sensitivity	.052	-.054	.124	-.143	—				
4. Parental nighttime involvement				—					
3. The severity of sleep problems			—						
2. Attachment Resistance		—							
1. Attachment Security	—								

Note: **. Correlation is significant at the 0.01 level. DASS21= Depression, Stress, Anxiety Scale (21 Items).

Predictors of attachment and sleep variables (*n* = 18). Using the infant and parent variables, a standard multiple linear regression was calculated to develop a model for predicting attachment and sleep variables. First, variables that correlated with each predicted variable significantly or at level $r > .30$ were detected. Among these variables, the ones which had the highest correlations with each predicted variable and were not significantly correlated with each other were selected to run the analysis. A predictive model with significant contribution to explain the variance in attachment variables could not be generated. The severity of sleep problems and parental nighttime involvement variables had significant predicting models.

The severity of sleep problems. The selected predictor variables were parental nighttime involvement (M = 4.48, SD = .77), frequency of observed negative emotionality (M = 4.39, SD = 3.8), MCISQ Limit Setting subscale (M = 17.50, SD = 4.5), and attachment resistance (M = 4.39, SD = 2.25). Preliminary analyses were performed on multicollinearity, normality, linearity, and outliers to ensure there was no violation of the assumption of normality.

A significant regression equation was found (F (4, 13) = 5.775, p = .007) with an R^2 of .640 and with an adjusted R^2 of .529. Standard error of the estimate was 2.104. Parental involvement at nighttime (β=.403, p<.05, 95% CI [.105-3.080]) and attachment resistance (β=.377, p<.05, 95% CI [-1.018-.009]) made a unique contribution to the prediction of the model. Parental nighttime involvement had the largest contribution explaining 14% of the variance. Lower scores on attachment resistance explained 13% of the variance (See Table 26).

Table 26. *Summary of standard multiple linear regression analysis for variables predicting the severity of the sleep problem at Phase-1 (n=18)*

	The severity of sleep problems				
Variable	*B*	*SE B*	*β*	*t*	*p*
Parental nighttime involvement	1.593	.688	.403	2.313	**.038***
Attachment resistance	-.513	.234	-.377	-2.198	**.047***
Frequency of observed NE	-.277	.142	-.345	-1.946	.074
MCISQ Limit Setting	.165	.117	.247	1.411	.182
R^2(adj. R^2)		.640 (.529)			
F		5.775			**.007****

Note: * p<.05, **p<.01

Parental nighttime involvement. The selected predictor variables were the severity of sleep problems (*M* = 13.89, *SD* = 3.06), Cry duration at SSP separation episodes (*M* = 21.83, *SD* = 12.47), and MCISQ Doubt subscale (*M* = 8.56, *SD* = 4.5). Preliminary analyses were performed on multicollinearity, normality, linearity, and outliers to ensure there was no violation of the assumption of normality.

A significant regression equation was found (F (3, 14) =4.620, p=.019) with an R^2 of .497 and with an adjusted R^2 of .390. Standard error of the estimate was .60601. Among these predictor variables, only the severity of sleep problems made a significant contribution to the model (β = .558, p<.05, 95% CI [.037.245]) and explained 30% of the variance (See Table 27).

Table 27. *Summary of standard multiple linear regression analysis for variables predicting parental nighttime involvement at Phase-1 (n=18)*

	Parental nighttime involvement				
Variable	*B*	*SE B*	*β*	*t*	*p*
The severity of sleep problem	.141	.048	.558	2.918	**.011***
Cry duration at SSP Separation Episodes	.013	.012	.205	1.060	.307
MCISQ Doubt	-.062	.033	-.366	-1.897	.079
R^2(adj. R^2)		.497 (.390)			
F		4.620			**.019***

Note: * p<.05.

Appendix J: Supplementary Information on Level 2 Analyses

Details on the Phase Durations. Although all participants were randomly assigned to baseline lengths, eight intervention participants had longer baseline lengths than assigned, owing to family circumstances not being convenient to begin an intense phase of changing routines at the scheduled time. Therefore, for intervention families, Phase-1 continued until parents were ready to begin the intervention. During Phases 3 and 4, when infants were sick or there were other technical difficulties, parents extended data collection by a further week within the phase. Phase-1 length varied from 7 to 48 days for treated infants and 7 to 29 days for comparison infants, Phase-2 varied between 24-55 days for treated infants but was 28 days for comparison infants. Although Phase-3 was planned to be at least seven days for all participants, some families in the intervention group were willing to continue keeping the sleep diary continuously from the end of Phase-2 until the end of Phase-3 and there was also miscommunication about phase durations with some families, resulting in the final duration of Phase-3 ranging from 6 to 32 days for treated infants and five to seven days for the comparison infants.

Phase-4 was planned to begin around the time when the second SSP was due, which was from four to six months after the beginning of Phase-1. In practice, Phase-4 began, at the earliest, four months after the beginning of Phase-1 and after 7.3 months at the longest time. Phase-4 was planned to be seven days in duration, however, due to holidays and sicknesses the final duration for treated infants ranged from 6 to 21 days, but was seven days for all comparison infants.

Illnesses and missing data. Robyn was the most frequently sick infant, having 36 days ill followed by Kirk with 20 days and there was a disruption to Kirk's family's routine on Phase-3 for 6 days in total. Robyn had sick days on every phase and Kirk was sick on Phases-1, 2, and 4. Sheryl was sick for 18 days in total and had sick days on every phase. Robert and

Yvonne was sick for 16 days in total, Yvonne was sick on every phase and Robert had sick days on Phases 1 and 2. Rebecca followed with 13 sick days on phases 1, 3, and 4. Hannah was sick for 10 days at Phase-3 for which the data were missing. Hamish got sick for seven days in total. Wendy and Mike had the least number of sick days with two. Wendy and Kirk's parents continued filling out the sleep diary after the intervention finished until the end of the night camera recordings. Yvonne's and Hannah's parents filled out additional diaries at Phase-3 because the children were sick for a long time and there were some disruptions to the family routine. Kirk's and Robyn's parents were also asked to fill out extra week of sleep diaries during Phase-4 because of illnesses. Whereas, four children in comparison group got sick seven to nine days throughout the study except for Scott (20 days) and Peter (15 days) who had sick days at every phase. There were missing data at baseline for Hamish. Robert's data had missing days at baseline and Phase-2 because of sickness, Hannah at Phase-3 due to sickness, Robyn's Phase-1 one week of sleep diary was lost, and some nights were missing in the diaries of Alan, Mere, Peter, and Ben in comparison infants.

Appendix K: Supplementary modified Brinley Plots from Level 3 Analyses

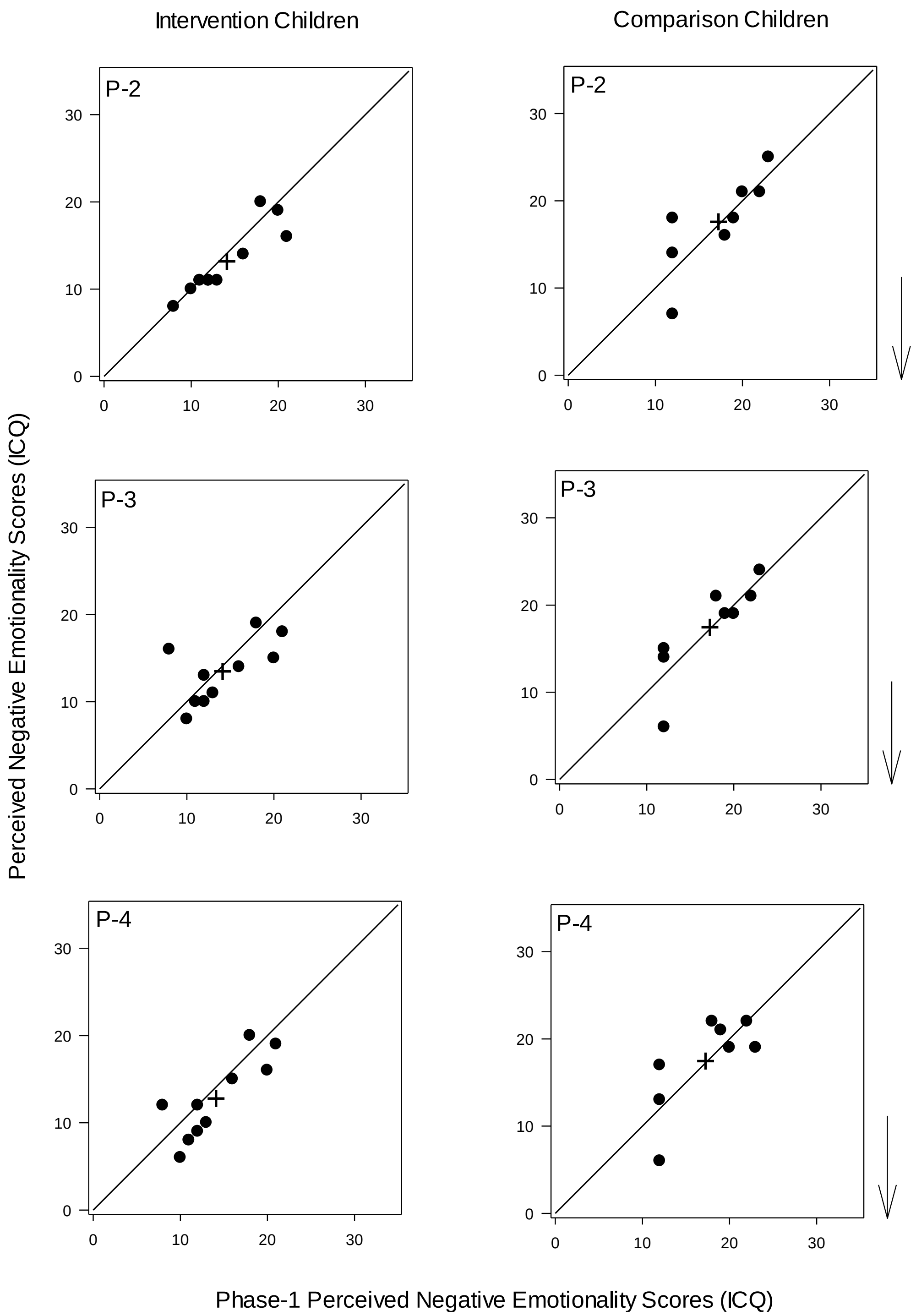

Figure 30. Modified Brinley Plot of Perceived Negative Emotionality as measured by ICQ within and across participants, across phases.

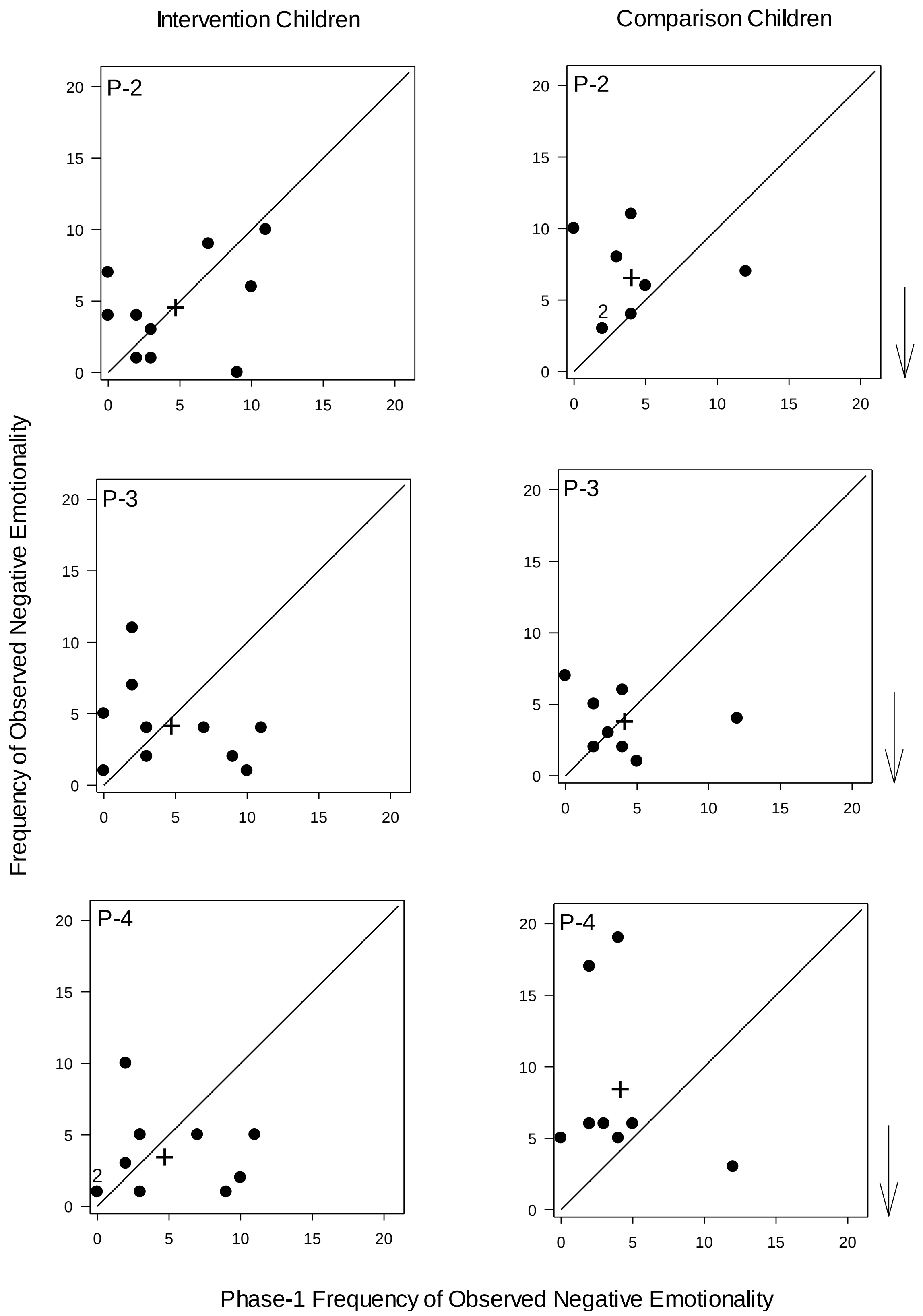

Figure 31. Modified Brinley Plot of Frequency of Observed Negative Emotionality within and across participants, across phases.

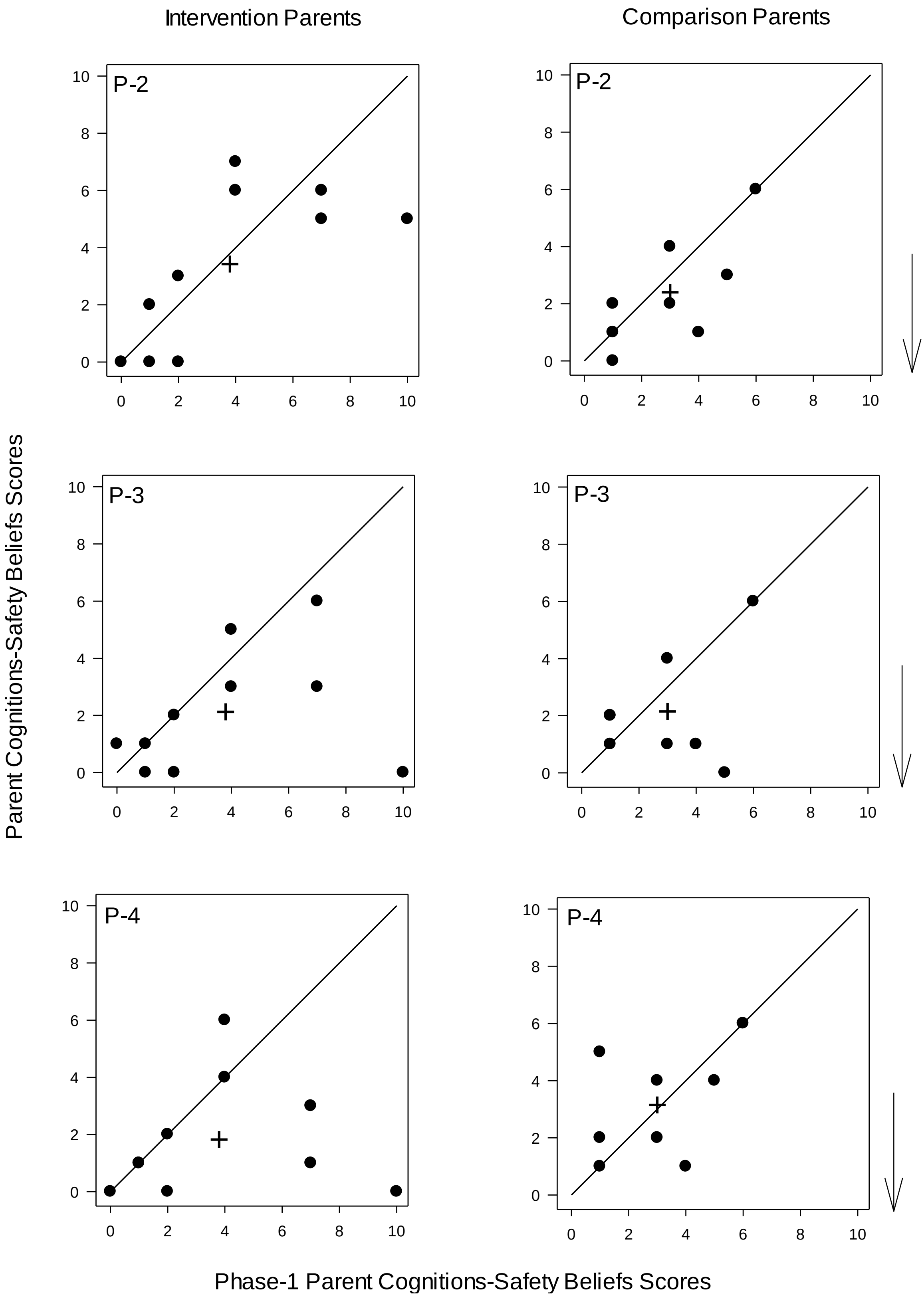

Figure 32. Modified Brinley Plot of MCISQ Feeding subscale within and across participants, across phases

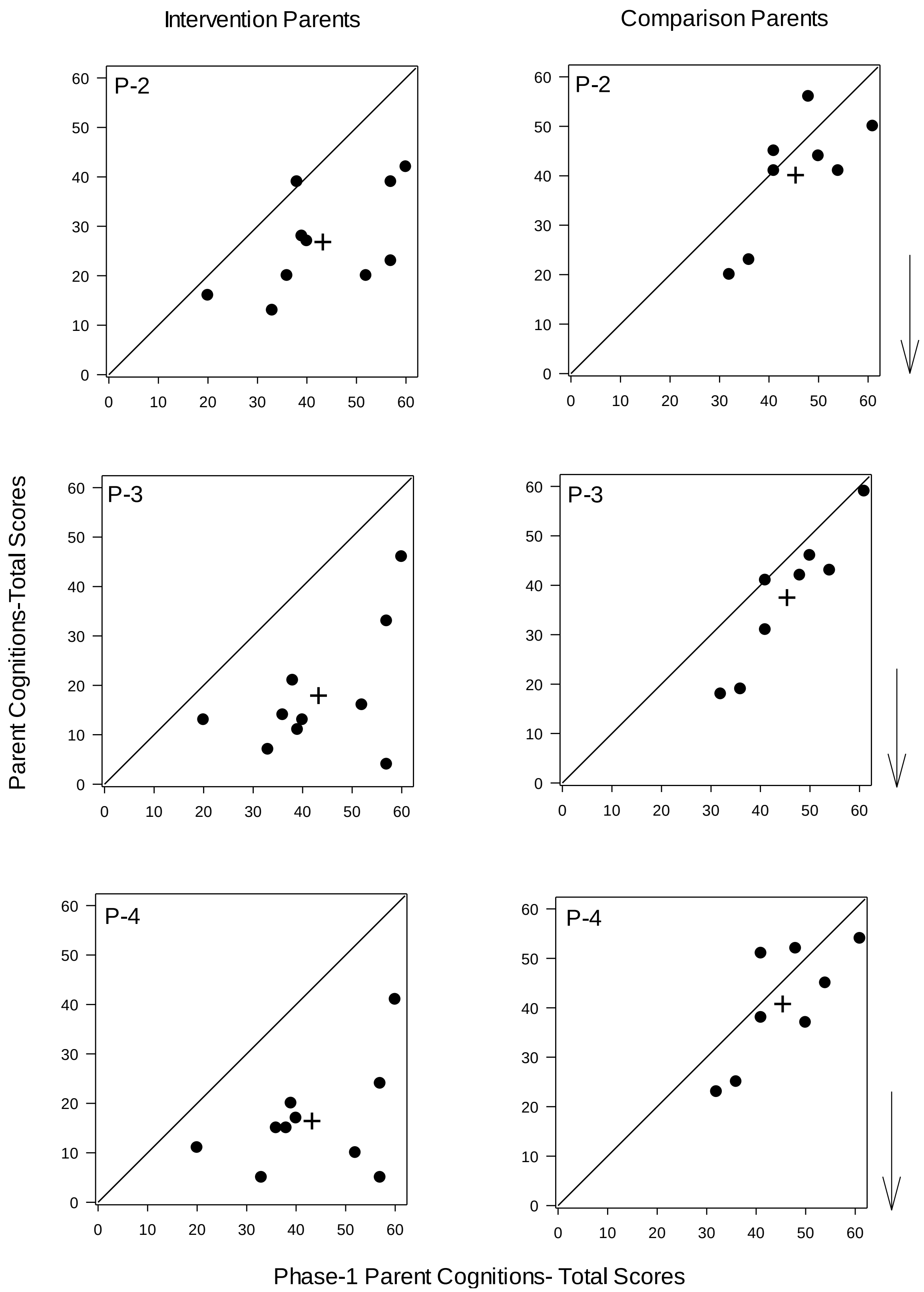

Figure 33. Modified Brinley Plot of MCISQ Total Score within and across participants, across phases

Appendix L. The Poster (with Preliminary Data) Presented at 2017 World Sleep Conference

Canterbury Sleep Programme
School of Health Sciences
Department of Psychology
University of Canterbury

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

What parent and child factors predict parental help-seeking for Paediatric Sleep Disturbance (PSD)?

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School of Health Sciences[1], Department of Psychology[2]

INTRODUCTION

- ~30% of families in New Zealand experience PSD (Teng, Bartle, Sadeh, & Mindell, 2012).
- PSD development is explained by the role of proximal and distal factors including those of social learning theory (France & Blampied, 1999; Sadeh, Tikotzky, & Scher, 2010).
- Persistent PSD may have detrimental effects on later development of children and on parents' well-being (Sadeh, Mindell, & Owens, 2011).
- The most effective and evidence-based methods to resolve PSD are Behavioural Sleep Interventions (BSI) (Meltzer & Mindell, 2014).
- According to Etherton, Blunden, and Hauck (2016), some parents may not want to implement BSI for reasons such as difficulty coping with infants' cries and different parenting beliefs.
- There is no study to date to empirically examine the characteristics of families who may or may not want to implement a BSI.

Research Question

Among families whose children have PSD, what parent and child factors assessed at initial contact predict parental willingness to participate in a Behavioural Sleep Intervention?

METHOD

Design

Cross-sectional study with two naturally-formed groups.

Participants

- Families with 1 year old infants (N=25, age range=11-16 months)
- Frequent night wakings and/or took at least 30 minutes to settle to sleep
- Help-seek group (n=15, mean age=13.11±1.41, 47% boys)
- Non-help-seek group (n=10, mean age=13.10±1.19, 70%boys)

Variables and Measures

Demographics: Infant age, gender, day-care attendance, night time breastfeeding, previous BSI experience, SES, Parity, Parent age, relationship and working status

Infant level: The onset age of PSD, Perceived Fussy/Difficult Temperament (via ICQ), Observed Negative Emotionality, Cry Durations at the Separation Episodes of the Strange Situation Procedure (SSP), Attachment Patterns (ABC model)

Parent level: Infants' Sleep Arrangement, Parental Cognitions about Infant Sleep (via MCISQ) with subscales *i) Difficulty with limit setting at bedtime, ii) Doubt, iii) Safety, iv) Feeding, v) Anger*, Parental Depression, Stress, Anxiety (via DASS-21), Parental Sensitivity (via MBQS-25v)

PROCEDURE

- *Clinic visit*: Intake interview for sleep history and demographics and the Strange Situation Procedure (SSP) were conducted.
- *Home visit*: 15 minutes of mother-infant play was video-recorded to assess maternal sensitivity and infant negative emotionality. Parents filled out self-report questionnaires.

RESULTS

Step 1: Descriptive Analysis

- There were no significant differences between groups in demographics, infant temperament, negative emotionality, attachment patterns, parental sensitivity, and mood.

Infant Level

PSD since birth

- **90%** Non-help-seek group
- **40%** Help-seek group (χ^2= 6.250, p<.05).

Cry duration at SSP Separation Episodes

- Infants in the non-help-seek group cried **longer** than infants in the help-seek group (Cohen's d=.88, r_{pb}=.40, p<.05).

Table-1 The Discriminant Function Analysis Classification Results[a,c]

			Predicted Group Membership		
		Group	do not seek help	seek help	Total
Original	Count	do not seek help	8	2	10
		seek help	1	14	15
	%	do not seek help	80.0	20.0	100.0
		seek help	6.7	93.3	100.0
Cross-validated[b]	Count	do not seek help	8	2	10
		seek help	1	14	15
	%	do not seek help	80.0	20.0	100.0
		seek help	6.7	93.3	100.0

a. 88.0% of original grouped cases correctly classified.
b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.
c. 88.0% of cross-validated grouped cases correctly classified.

Parent Level

Intentional cosleep

- **60%** in the non-help-seek group vs **none** in the help-seek group (χ^2=11.842, p=.001).

Difficulty with Limit Setting at Bedtime subscale of MCISQ

- The non-help-seek group scored **higher** than the help-seek group (Cohen's d=1.21, r_{pb}=.51, p<.01).

Step 2: Predicting group membership via Discriminant Function Analysis (DFA)

- Infant Cry Duration at SSP Separation Episodes (Wilk's λ=.832, p<.01) and Parent scores of Difficulty with Limit Setting at Bedtime (Wilk's λ=.732, p<.01), showed **strong predictive accuracy** for group membership.
- As seen in Table 1, DFA **correctly classified** 8/10 of the non-help-seek group and 14/15 of the help-seek group with *overall accuracy* of 88%, Wilk's λ=.615, Cannonical r= .620, p<.01.

CONCLUSION

- Having less difficulty with limit setting at bedtime and having infants less distressed at separation strongly predicted parents' willingness to participate in a BSI.
- Parents who did not seek help experienced longer-standing PSD and were more likely to practice intentional cosleeping.
- Investigation of parents' attitudes and parenting practices may throw more light on parents' decision making processes.

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